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(54) Title: NOVEL LOW DENSITY LIPOPROTEIN BINDING PROTEINS AND THEIR USE IN DIAGNOSING AND TREATING ATHEROSCLEROSIS		
(57) Abstract Isolated polynucleotides encoding novel polypeptides which are capable of binding to native and methylated LDL (low density lipoprotein), the isolated polypeptides, called LBPs (LDL binding proteins), and biologically active fragments and analogs thereof, are described. Also described are methods for determining if an animal is at risk for atherosclerosis, methods for evaluating an agent for use in treating atherosclerosis, methods for treating atherosclerosis, and methods for treating a cell having an abnormality in structure or metabolism of LBP. Pharmaceutical compositions and vaccine compositions are also provided.		

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**NOVEL LOW DENSITY LIPOPROTEIN BINDING PROTEINS AND
THEIR USE IN DIAGNOSING AND TREATING ATHEROSCLEROSIS**

Field of the Invention

5 This application claims the benefit of U.S. Provisional Application No. 60/031,930 filed November 27, 1996, and U.S. Provisional Application No. 60/048,547 filed June 3, 1997.

 This invention relates to novel polypeptides (LBPs) which bind to low density lipoprotein (LDL), polynucleotides which encode these polypeptides, and treatments, diagnoses and therapeutic agents for atherosclerosis.

10 **Background of the Invention**

 Atherosclerosis is the principal cause of heart attacks and strokes. It has been reported that about 50% of all deaths in the United States, Europe and Japan are due to atherosclerosis. Atherosclerotic lesions in the arterial wall characterize atherosclerosis. Cholesteryl esters (CE)
15 are present in these atherosclerotic lesions. Low density lipoprotein (LDL) has been shown to be the major carrier of plasma CE, and has been implicated as the agent by which CE enter the atherosclerotic lesions.

 Scattered groups of lipid-filled macrophages, called foam cells, are the first visible signs of atherosclerosis and are described as type I lesions. These macrophages are reported to contain
20 CE derived from LDL. The macrophages recognize oxidized LDL, but not native LDL, and become foam cells by phagocytosing oxidized LDL. Larger, more organized collections of foam cells, fatty streaks, represent type II lesions. These lesions further develop into complex lesions called plaques, which can result in impeding the flow of blood in the artery.

 It is widely believed that accumulation of LDL in the artery depends on the presence of
25 functionally modified endothelial cells in the arterial wall. It has been reported in animal models of atherosclerosis that LDL, both native LDL and methylated LDL, accumulates focally and irreversibly only at the edges of regenerating endothelial islands in aortic lesions, where functionally modified endothelial cells are present, but not in the centers of these islands where endothelial regeneration is completed. Similarly, LDL accumulates in human atherosclerotic
30 lesions. The mechanism by which the LDL accumulates focally and irreversibly in arterial lesions has not heretofore been understood.

Summary of the Invention

 It is an object of the invention to provide polypeptides which bind to LDL.

35 It is yet another object of the invention to provide a method for determining if an animal

is at risk for atherosclerosis.

It is yet another object of the invention to provide a method for evaluating an agent for use in treating atherosclerosis.

It is yet another object of the invention to provide a method for treating atherosclerosis.

5 Still another object of the invention is to utilize an LBP (low density lipoprotein binding protein) gene and/or polypeptide, or fragments, analogs and variants thereof, to aid in the treatment, diagnosis and/or identification of therapeutic agents for atherosclerosis.

In one aspect, the invention features an isolated polynucleotide comprising a polynucleotide encoding the polypeptide comprising the amino acid sequence as set forth in SEQ
10 ID NO:1, SEQ ID NO:2, SEQ ID NO:3, SEQ ID NO:4, SEQ ID NO:5, SEQ ID NO:6, SEQ ID NO:7, SEQ ID NO:8 or SEQ ID NO:9; or a polynucleotide capable of hybridizing to and which is at least about 95% identical to any of the above polynucleotides and wherein the encoded polypeptide is capable of binding to LDL; or a biologically active fragment of any of the above polynucleotides wherein the encoded polypeptide is capable of binding to LDL.

15 In certain embodiments, the polynucleotide comprises the nucleic acid sequence as set forth in SEQ ID NO:10, SEQ ID NO:11, SEQ ID NO:12, SEQ ID NO:13, SEQ ID NO:14, SEQ ID NO:15, SEQ ID NO:16, SEQ ID NO:17 or SEQ ID NO:18.

Another aspect of the invention is an isolated polypeptide comprising a polypeptide having the amino acid sequence as set forth in SEQ ID NO:1, SEQ ID NO:2, SEQ ID NO:3,
20 SEQ ID NO:4, SEQ ID NO:5, SEQ ID NO:6, SEQ ID NO:7, SEQ ID NO:8 or SEQ ID NO:9; or a polypeptide which is at least about 95% identical to any of the above polypeptides and wherein the polypeptide is capable of binding to LDL; or a biologically active fragment of any of the above polypeptides wherein the fragment is capable of binding to LDL.

Another aspect of the invention is a method for determining if an animal is at risk for
25 atherosclerosis. An animal is provided. An aspect of LBP metabolism or structure is evaluated in the animal. An abnormality in the aspect of LBP metabolism or structure is diagnostic of being at risk for atherosclerosis.

Another aspect of the invention is a method for evaluating an agent for use in treating atherosclerosis. A test cell, cell-free system or animal is provided. An agent is provided. The
30 agent is administered to the test cell, cell-free system or animal in a therapeutically effective amount. The effect of the agent on an aspect of LBP metabolism or structure is evaluated. A change in the aspect of LBP metabolism or structure is indicative of the usefulness of the agent

in treating atherosclerosis.

Another aspect of the invention is a method for evaluating an agent for the ability to alter the binding of LBP polypeptide to a binding molecule, e.g., native LDL, modified LDL, e.g., methylated LDL or oxidized LDL, or an arterial extracellular matrix structural component. An agent is provided. An LBP polypeptide is provided. A binding molecule is provided. The agent, LBP polypeptide and binding molecule are combined. The formation of a complex comprising the LBP polypeptide and binding molecule is detected. An alteration in the formation of the complex in the presence of the agent as compared to in the absence of the agent is indicative of the agent altering the binding of the LBP polypeptide to the binding molecule.

Another aspect of the invention is a method for evaluating an agent for the ability to bind to an LBP polypeptide. An agent is provided. An LBP polypeptide is provided. The agent is contacted with the LBP polypeptide. The ability of the agent to bind to the LBP polypeptide is evaluated.

Another aspect of the invention is a method for evaluating an agent for the ability to bind to a nucleic acid encoding an LBP regulatory sequence. An agent is provided. A nucleic acid encoding an LBP regulatory sequence is provided. The agent is contacted with the nucleic acid. The ability of the agent to bind to the nucleic acid is evaluated.

Another aspect of the invention is a method for treating atherosclerosis in an animal. An animal in need of treatment for atherosclerosis is provided. An agent capable of altering an aspect of LBP structure or metabolism is provided. The agent is administered to the animal in a therapeutically effective amount such that treatment of the atherosclerosis occurs. In certain embodiments, the agent is an LBP polypeptide, e.g., LBP-1, LBP-2 or LBP-3, or a biologically active fragment or analog thereof. In certain embodiments, the agent is a polypeptide of no more than about 100, 50, 30, 20, 10, 5, 4, 3 or 2 amino acid residues in length. In certain embodiments, the agent is a polypeptide having an amino acid sequence that includes at least about 20%, 40%, 60%, 80%, 90%, 95% or 98% acidic amino acid residues.

Another aspect of the invention is a method for treating an animal at risk for atherosclerosis. An animal at risk for atherosclerosis is provided. An agent capable of altering an aspect of LBP structure or metabolism is provided. The agent is administered to the animal in a therapeutically effective amount such that treatment of the animal occurs.

Another aspect of the invention is a method for treating a cell having an abnormality in structure or metabolism of LBP. A cell having an abnormality in structure or metabolism of

LBP is provided. An agent capable of altering an aspect of LBP structure or metabolism is provided. The agent is administered to the cell in a therapeutically effective amount such that treatment of the cell occurs.

Another aspect of the invention is a pharmaceutical composition for treating
5 atherosclerosis in an animal comprising a therapeutically effective amount of an agent, the agent being capable of altering an aspect of LBP metabolism or structure in the animal so as to result in treatment of the atherosclerosis, and a pharmaceutically acceptable carrier.

Another aspect of the invention is a vaccine composition for treating atherosclerosis in an animal comprising a therapeutically effective amount of an agent, the agent being capable of
10 altering an aspect of LBP metabolism or structure in the animal so as to result in treatment of the atherosclerosis, and a pharmaceutically acceptable carrier.

Another aspect of the invention is a method for diagnosing atherosclerotic lesions in an animal. An animal is provided. A labeled agent capable of binding to LBP, e.g., LBP-1, LBP-2 or LBP-3, present in atherosclerotic lesions is provided. The labeled agent is administered to the
15 animal under conditions which allow the labeled agent to interact with the LBP so as to result in labeled LBP. The localization or quantification of the labeled LBP is determined by imaging so as to diagnose the presence of atherosclerotic lesions in the animal.

Another aspect of the invention is a method for immunizing an animal against an LBP, e.g., LBP-1, LBP-2 or LBP-3, or fragment or analog thereof. An animal having LDL is
20 provided. The LBP or fragment or analog thereof is administered to the animal so as to stimulate antibody production by the animal to the LBP or fragment or analog thereof such that binding of the LBP to the LDL is altered, e.g., decreased or increased.

Another aspect of the invention is a method of making a fragment or analog of LBP polypeptide, the fragment or analog having the ability to bind to native LDL and to modified
25 LDL, e.g., methylated LDL, oxidized LDL, acetylated LDL, or cyclohexanedione-treated LDL. An LBP polypeptide is provided. The sequence of the LBP polypeptide is altered. The altered LBP polypeptide is tested for the ability to bind to modified LDL and native LDL.

Yet another aspect of the invention is a method for isolating a cDNA encoding an LBP. A cDNA library is provided. The cDNA library is screened for a cDNA encoding a polypeptide
30 which binds to native LDL and modified LDL, e.g., methylated LDL or oxidized LDL. The cDNA which encodes the polypeptide is isolated, the cDNA encoding an LBP.

The above and other features, objects and advantages of the present invention will be

better understood by a reading of the following specification in conjunction with the drawings.

Brief Description of the Drawings

Fig. 1 depicts the amino acid sequence of rabbit LBP-1 (SEQ ID NO:1). Differences in
5 amino acids between rabbit and human LBP-1 are depicted in bold type.

Fig. 2 depicts the amino acid sequence of rabbit LBP-2 (SEQ ID NO:2). Differences in
amino acids between rabbit and human LBP-2 are depicted in bold type.

Fig. 3 depicts the amino acid sequence of amino acids 86 to 317 of rabbit LBP-2 (SEQ ID
NO:3).

10 Fig. 4 depicts the amino acid sequence of amino acids 66 to 317 of rabbit LBP-2 (SEQ ID
NO:4).

Fig. 5 depicts the amino acid sequence of rabbit LBP-3 (SEQ ID NO:5). Differences in
amino acids between rabbit and human LBP-3 are depicted in bold type.

Fig. 6 depicts the amino acid sequence of human LBP-1 (SEQ ID NO:6). Differences in
15 amino acids between rabbit and human LBP-1 are depicted in bold type.

Fig. 7 depicts the amino acid sequence of human LBP-2 (SEQ ID NO:7). Differences in
amino acids between rabbit and human LBP-2 are depicted in bold type.

Fig. 8 depicts the amino acid sequence of human LBP-3 (SEQ ID NO:8). Differences in
amino acids between rabbit and human LBP-3 are depicted in bold type.

20 Fig. 9 depicts the amino acid sequence of amino acids 14 to 33 of human or rabbit
LBP-1, called BHF-1 (SEQ ID NO:9).

Fig. 10 depicts the cDNA sequence encoding rabbit LBP-1 (SEQ ID NO:10) and the
corresponding amino acid sequence. Differences in amino acids between rabbit and human
LBP-1 are depicted in bold type.

25 Fig. 11 depicts the cDNA sequence encoding rabbit LBP-2 (SEQ ID NO:11) and the
corresponding amino acid sequence. Differences in amino acids between rabbit and human
LBP-2 are depicted in bold type.

Fig. 12 depicts the cDNA sequence 256 to 1617 of rabbit LBP-2 (SEQ ID NO:12) and
the corresponding amino acid sequence.

30 Fig. 13 depicts the cDNA sequence 196 to 1617 of rabbit LBP-2 (SEQ ID NO:13) and
the corresponding amino acid sequence.

Fig. 14 depicts the cDNA sequence encoding rabbit LBP-3 (SEQ ID NO:14) and the
corresponding amino acid sequence. Differences in amino acids between rabbit and human

LBP-3 are depicted in bold type.

Fig. 15 depicts the cDNA sequence encoding human LBP-1 (SEQ ID NO:15) and the corresponding amino acid sequence. Differences in amino acids between rabbit and human LBP-1 are depicted in bold type.

5 Fig. 16 depicts the cDNA sequence encoding human LBP-2 (SEQ ID NO:16) and the corresponding amino acid sequence. Differences in amino acids between rabbit and human LBP-2 are depicted in bold type.

Fig. 17 depicts the cDNA sequence encoding human LBP-3 (SEQ ID NO:17) and the corresponding amino acid sequence. Differences in amino acids between rabbit and human
10 LBP-3 are depicted in bold type.

Fig. 18 depicts the cDNA sequence encoding BHF-1 (SEQ ID NO:18).

Fig. 19 corresponds to the amino acid sequence of rabbit LBP-1 (top sequence) in alignment with the amino acid sequence of human LBP-1 (bottom sequence).

Fig. 20 corresponds to the amino acid sequence of rabbit LBP-2 (top sequence) in
15 alignment with the amino acid sequence of human LBP-2 (bottom sequence).

Fig. 21 corresponds to the amino acid sequence of rabbit LBP-3 (top sequence) in alignment with the amino acid sequence of human LBP-3 (bottom sequence).

Detailed Description

20 In accordance with aspects of the present invention, there are provided novel mature human and rabbit polypeptides, LBP-1, LBP-2 and LBP-3, and biologically active analogs and fragments thereof, and there are provided isolated polynucleotides which encode such polypeptides. LBP is an abbreviation for low density lipoprotein (LDL) binding protein. The terms polynucleotide, nucleotide and oligonucleotide are used interchangeably herein, and the
25 terms polypeptides, proteins and peptides are used interchangeably herein.

This invention provides for an isolated polynucleotide comprising a polynucleotide encoding the polypeptide having the amino acid sequence of rabbit LBP-1 as set forth in Fig. 1 (SEQ ID NO:1); rabbit LBP-2 as set forth in Fig. 2 (SEQ ID NO:2); 86 to 317 of rabbit LBP-2 as set forth in Fig. 3 (SEQ ID NO:3); 66 to 317 of rabbit LBP-2 as set forth in Fig. 4 (SEQ ID
30 NO:4); rabbit LBP-3 as set forth in Fig. 5 (SEQ ID NO:5); human LBP-1 as set forth in Fig. 6 (SEQ ID NO:6); human LBP-2 as set forth in Fig. 7 (SEQ ID NO:7); human LBP-3 as set forth in Fig. 8 (SEQ ID NO:8); 14 to 33 of human or rabbit LBP-1, called BHF-1, as set forth in Fig. 9 (SEQ ID NO:9); a polynucleotide capable of hybridizing to and which is at least about 80%

identical, more preferably at least about 90% identical, more preferably yet at least about 95% identical, and most preferably at least about 98% identical to any of the above polynucleotides, and wherein the encoded polypeptide is capable of binding to LDL; or a biologically active fragment of any of the above polynucleotides wherein the encoded polypeptide is capable of
5 binding to LDL.

This invention also includes an isolated polynucleotide comprising a polynucleotide encoding the polypeptide having amino acid residues 8-22 (SEQ ID NO:19), 8-33 (SEQ ID NO:20), 23-33 (SEQ ID NO:21) or 208-217 (SEQ ID NO:22) of human LBP-2 as set forth in Fig. 7 (SEQ ID NO:7); amino acid residues 14-43 (SEQ ID NO:23) or 38-43 (SEQ ID NO:24) of
10 rabbit or human LBP-1 as set forth in Fig. 1 (SEQ ID NO:1) and Fig. 6 (SEQ ID NO:6); amino acid residues 105-120 (SEQ ID NO:25), 105-132 (SEQ ID NO:26), 121-132 (SEQ ID NO:27) or 211-220 (SEQ ID NO:28) of rabbit LBP-2 as set forth in Fig. 2 (SEQ ID NO:2); amino acid residues 96-110 (SEQ ID NO:29) of rabbit LBP-3 as set forth in Fig. 5 (SEQ ID NO:5); amino acid residues 53-59 (SEQ ID NO:41) of human LBP-3 as set forth in Fig. 8 (SEQ ID NO:8); a
15 polynucleotide capable of hybridizing to and which is at least about 80% identical, more preferably at least about 90% identical, more preferably yet at least about 95% identical, and most preferably at least about 98% identical to any of the above polynucleotides, and wherein the encoded polypeptide is capable of binding to LDL; or a biologically active fragment of any of the above polynucleotides wherein the encoded polypeptide is capable of binding to LDL.

By a polynucleotide encoding a polypeptide is meant a polynucleotide which includes only coding sequence for the polypeptide, as well as a polynucleotide which includes additional coding and/or non-coding sequences. Thus, e.g., the polynucleotides which encode for the mature polypeptides of Figs. 1-9 (SEQ ID NOS:1-9) may include only the coding sequence for the mature polypeptide; the coding sequence for the mature polypeptide and additional coding
25 sequence such as a leader or secretory sequence or a proprotein sequence; the coding sequence for the mature polypeptide (and optionally additional coding sequence) and non-coding sequence, such as introns or non-coding sequences 5' and/or 3' of the coding sequence for the mature polypeptide. The polynucleotides of the invention are also meant to include polynucleotides in which the coding sequence for the mature polypeptide is fused in the same
30 reading frame to a polynucleotide sequence which aids in expression and/or secretion of a polypeptide from a host cell, e.g., a leader sequence. The polynucleotides are also meant to include polynucleotides in which the coding sequence is fused in frame to a marker sequence

which, e.g., allows for purification of the polypeptide.

The polynucleotides of the present invention may be in the form of RNA, DNA or PNA, e.g., cRNA, cDNA, genomic DNA, or synthetic DNA, RNA or PNA. The DNA may be double-stranded or single stranded, and if single stranded may be the coding strand or non-coding (anti-sense) strand.

In preferred embodiments, the polynucleotide comprises the nucleic acid of rabbit LBP-1 as set forth in Fig. 10 (SEQ ID NO:10); rabbit LBP-2 as set forth in Fig. 11 (SEQ ID NO:11); nucleotide 256 to 1617 of rabbit LBP-2 as set forth in Fig. 12 (SEQ ID NO:12); nucleotide 196 to 1617 of rabbit LBP-2 as set forth in Fig. 13 (SEQ ID NO:13); rabbit LBP-3 as set forth in Fig. 14 (SEQ ID NO:14); human LBP-1 as set forth in Fig. 15 (SEQ ID NO:15); human LBP-2 as set forth in Fig. 16 (SEQ ID NO:16); human LBP-3 as set forth in Fig. 17 (SEQ ID NO:17); or nucleotide 97 to 156 of rabbit LBP-1 or nucleotide 157 to 216 of human LBP-1, (BHF-1), as set forth in Fig. 18 (SEQ ID NO:18).

In other preferred embodiments, the polynucleotide comprises the nucleic acid as set forth in SEQ ID NO:30, SEQ ID NO:31, SEQ ID NO:32, SEQ ID NO:33, SEQ ID NO:34, SEQ ID NO:35, SEQ ID NO:36, SEQ ID NO:37, SEQ ID NO:38, SEQ ID NO:39, SEQ ID NO:40 or SEQ ID NO:42.

The coding sequence which encodes the mature polypeptide may be identical to the coding sequences shown in Figs. 10-18 (SEQ ID NOS:10-18) or SEQ ID NOS:30-40 or 42, or may be a different coding sequence which coding sequence, as a result of the redundancy or degeneracy of the genetic code, encodes the same mature polypeptides as the DNA of Figs. 10-18 (SEQ ID NOS:10-18) and SEQ ID NOS: 30-40 and 42.

This invention also includes recombinant vectors comprising the polynucleotides described above. The vector can be, e.g., a plasmid, a viral particle or a phage. In certain embodiments, the recombinant vector is an expression vector. The vectors may also include various marker genes which are useful in identifying cells containing such vectors.

This invention also includes a cell comprising such a recombinant vector. The recombinant vectors described herein can be introduced into a host cell, e.g., by transformation, transfection or infection.

This invention also includes a method for producing an LBP comprising culturing such a cell under conditions that permit expression of the LBP.

This invention also includes an isolated polypeptide comprising a polypeptide having the

amino acid sequence as set forth in Fig. 1 (SEQ ID NO:1); Fig. 2 (SEQ ID NO:2); Fig. 3 (SEQ ID NO:3); Fig. 4 (SEQ ID NO:4); Fig. 5 (SEQ ID NO:5); Fig. 6 (SEQ ID NO:6); Fig. 7 (SEQ ID NO:7); Fig. 8 (SEQ ID NO:8) or Fig. 9 (SEQ ID NO:9); or a polypeptide which is at least about 80% identical, more preferably at least about 90% identical, more preferably yet at least about 5 95% identical, and most preferably at least about 98% identical to the above polypeptides, and wherein said polypeptide is capable of binding to LDL; or a biologically active fragment of any of the above polypeptides wherein the fragment is capable of binding to LDL. Differences in amino acids between the rabbit and human LBP-1, LBP-2 and LBP-3 genes are depicted in bold type in the figures. The differences in the amino acid sequences between rabbit and human LBP-1, LBP-2 and LBP-3 are also specifically shown in Figs. 19, 20 and 21, respectively.

This invention also includes an isolated polypeptide comprising a polypeptide having amino acid residues 8-22 (SEQ ID NO:19), 8-33 (SEQ ID NO:20), 23-33 (SEQ ID NO:21) or 208-217 (SEQ ID NO:22) as set forth in Fig. 7 (SEQ ID NO:7); amino acid residues 14-43 (SEQ ID NO:23) or 38-43 (SEQ ID NO:24) as set forth in Fig. 1 (SEQ ID NO:1) and Fig. 6 (SEQ ID NO:6); amino acid residues 105-120 (SEQ ID NO:25), 105-132 (SEQ ID NO:26), 121-132 (SEQ ID NO:27) or 211-220 (SEQ ID NO:28) as set forth in Fig. 2 (SEQ ID NO:2); amino acid residues 96-110 (SEQ ID NO:29) as set forth in Fig. 5 (SEQ ID NO:5); and amino acid residues 53-59 (SEQ ID NO:41) as set forth in Fig. 8 (SEQ ID NO:8); or a polypeptide which is at least about 80% identical, more preferably at least about 90% identical, more preferably yet at least 20 about 95% identical, and most preferably at least about 98% identical to the above polypeptides, and wherein said polypeptide is capable of binding to LDL; or a biologically active fragment of any of the above polypeptides wherein the fragment is capable of binding to LDL.

The polypeptides of the invention are meant to include, e.g., a naturally purified product, a chemically synthesized product, and a recombinantly derived product.

25 The polypeptides can be used, e.g., to bind to LDL, thereby inhibiting formation of atherosclerotic plaques. The polypeptides can also be used, e.g., in gene therapy, by expression of such polypeptides *in vivo*. The polypeptides can also be used in pharmaceutical or vaccine compositions. The polypeptides can also be used as immunogens to produce antibodies thereto, which in turn, can be used as antagonists to the LBP polypeptides.

30 Without being bound by any theory, it is believed that the LBPs provide the mechanism by which atherosclerosis is promoted through LDL oxidation. The LBPs are believed to be required in order for focal, irreversible LDL binding to occur at the arterial wall, and that such

binding is a critical early event in atherosclerosis because it allows the time necessary for LDL to be changed from its native state to a fully oxidized state. Since oxidized, but not native, LDL is a foreign protein, macrophages ingest it, first becoming the foam cells of type I lesions, and subsequently forming the fatty streaks of type II lesions.

5 This invention also includes a method for determining if an animal is at risk for atherosclerosis. An animal is provided. An aspect of LBP metabolism or structure is evaluated in the animal. An abnormality in the aspect of LBP metabolism or structure is diagnostic of being at risk for atherosclerosis.

 By atherosclerosis is meant a disease or condition which comprises several stages which
10 blend imperceptibly into each other, including irreversible binding of LDL, LDL oxidation, macrophage recruitment, blockage of the artery and tissue death (infarction).

 By animal is meant human as well as non-human animals. Non-human animals include, e.g., mammals, birds, reptiles, amphibians, fish, insects and protozoa. Preferably, the non-human animal is a mammal, e.g., a rabbit, a rodent, e.g., a mouse, rat or guinea pig, a primate, e.g., a
15 monkey, or a pig. An animal also includes transgenic non-human animals. The term transgenic animal is meant to include an animal that has gained new genetic information from the introduction of foreign DNA, i.e., partly or entirely heterologous DNA, into the DNA of its cells; or introduction of a lesion, e.g., an *in vitro* induced mutation, e.g., a deletion or other chromosomal rearrangement into the DNA of its cells; or introduction of homologous DNA into
20 the DNA of its cells in such a way as to alter the genome of the cell into which the DNA is inserted, e.g., it is inserted at a location which differs from that of the natural gene or its insertion results in a knockout or replacement of the homologous host gene or results in altered and/or regulatable expression and/or metabolism of the gene. The animal may include a transgene in all of its cells including germ line cells, or in only one or some of its cells. Transgenic animals of
25 the invention can serve as a model for studying atherosclerosis or for evaluating agents to treat atherosclerosis.

 In certain embodiments, the determination for being at risk for atherosclerosis is done in a prenatal animal.

 By LBP is meant a low density lipoprotein (LDL) binding protein which is capable of
30 binding LDL and methylated LDL. By methylated LDL is meant that about 50% to about 90% of the lysine residues of LDL have a methyl group chemically attached. Methylated LDL is not recognized by previously reported cell surface receptors. See, e.g., Weisgraber et al., J. Biol.

Chem. 253:9053-9062 (1978). In certain embodiments, the LBP is also capable of binding oxidized LDL. In certain preferred embodiments, the binding of LDL to an LBP is irreversible. In certain preferred embodiments, the LBP does not transport the LDL to any intracellular compartment. Examples of LBPs are LBP-1, LBP-2 and LBP-3 described herein.

5 By LBP metabolism is meant any aspect of the production, release, expression, function, action, interaction or regulation of LBP. The metabolism of LBP includes modifications, e.g., covalent or non-covalent modifications, of LBP polypeptide. The metabolism of LBP includes modifications, e.g., covalent or non-covalent modifications, that LBP induces in other substances. The metabolism of LBP also includes changes in the distribution of LBP
10 polypeptide, and changes LBP induces in the distribution of other substances.

Any aspect of LBP metabolism can be evaluated. The methods used are standard techniques known to those skilled in the art and can be found in standard references, e.g., Ausubel et al., ed., Current Protocols in Mol. Biology, New York: John Wiley & Sons, 1990; Kriegler, M., ed., Gene Transfer and Expression, Stockton Press, New York, NY, 1989; pDisplay
15 gene expression system (Invitrogen, Carlsbad, CA). Preferred examples of LBP metabolism that can be evaluated include the binding activity of LBP polypeptide to a binding molecule, e.g., LDL; the transactivation activity of LBP polypeptide on a target gene; the level of LBP protein; the level of LBP mRNA; the level of LBP modifications, e.g., phosphorylation, glycosylation or acylation; or the effect of LBP expression on transfected mammalian cell binding of LDL.

20 By binding molecule is meant any molecule to which LBP can bind, e.g., a nucleic acid, e.g., a DNA regulatory region, a protein, e.g., LDL, a metabolite, a peptide mimetic, a non-peptide mimetic, an antibody, or any other type of ligand. In certain preferred embodiments, the aspect of LBP metabolism that is evaluated is the ability of LBP to bind to native LDL and/or methylated LDL and/or oxidized LDL. Binding to LDL can be shown, e.g., by antibodies
25 against LDL, affinity chromatography, affinity coelectrophoresis (ACE) assays, or ELISA assays. See Examples. In other embodiments, it is the ability of LBP to bind to an arterial extracellular matrix structural component that is evaluated. Examples of such components include proteoglycans, e.g., chondroitin sulfate proteoglycans and heparin sulfate proteoglycans; elastin; collagen; fibronectin; vitronectin; integrins; and related extracellular matrix molecules.
30 Binding to arterial extracellular matrix structural components can be shown by standard methods known to those skilled in the art, e.g., by ELISA assays. Primary antibodies to the LBP are then added, followed by an enzyme-conjugated secondary antibody to the primary antibody, which

produces a stable color in the presence of an appropriate substrate, and color development on the plates is measured in a microtiter plate reader.

Transactivation of a target gene by LBP can be determined, e.g., in a transient transfection assay in which the promoter of the target gene is linked to a reporter gene, e.g., β -galacto-sidase or luciferase, and co-transfected with an LBP expression vector. Such evaluations
5 can be done in vitro or in vivo. Levels of LBP protein, mRNA or phosphorylation, can be measured, e.g., in a sample, e.g., a tissue sample, e.g., arterial wall, by standard methods known to those skilled in the art.

In certain embodiments, an aspect of LBP structure is evaluated, e.g., LBP gene structure
10 or LBP protein structure. For example, primary, secondary or tertiary structures can be evaluated. For example, the DNA sequence of the gene is determined and/or the amino acid sequence of the protein is determined. Standard cloning and sequencing methods can be used as are known to those skilled in the art. In certain embodiments, the binding activity of an antisense nucleic acid with the cellular LBP mRNA and/or genomic DNA is determined using standard
15 methods known to those skilled in the art so as to detect the presence or absence of the target mRNA or DNA sequences to which the antisense nucleic acid would normally specifically bind.

The risk for atherosclerosis that is determined can be a reduced risk or an increased risk as compared to a normal animal. For example, an abnormality which would give a reduced risk is an inactive LBP polypeptide. An abnormality which would give an increased risk would be,
20 e.g., an LBP polypeptide that has higher activity, e.g., LDL binding activity, than native LBP polypeptide.

The invention also includes a method for evaluating an agent for use in treating atherosclerosis. A test cell, cell-free system or animal is provided. An agent is provided. The agent is administered to the test cell, cell-free system or animal in a therapeutically effective
25 amount. The effect of the agent on an aspect of LBP metabolism or structure is evaluated. A change in the aspect of LBP metabolism or structure is indicative of the usefulness of the agent in treating atherosclerosis.

In certain embodiments, the method employs two phases for evaluating an agent for use in treating atherosclerosis, an initial in vitro phase and then an in vivo phase. The agent is
30 administered to the test cell or cell-free system in vitro, and if a change in an aspect of LBP metabolism occurs, then the agent is further administered to a test animal in a therapeutically effective amount and evaluated in vivo for an effect of the agent on an aspect of LBP

metabolism.

By cell is meant a cell or a group of cells, or a cell that is part of an animal. The cell can be a human or non-human cell. Cell is also meant to include a transgenic cell. The cell can be obtained, e.g., from a culture or from an animal. Animals are meant to include, e.g., natural
5 animals and non-human transgenic animals. In certain embodiments, the transgenic cell or non-human transgenic animal has an LBP transgene, or fragment or analog thereof. In certain embodiments, the transgenic cell or non-human transgenic animal has a knockout for the LBP gene.

The test cell, cell-free system or animal can have a wild type pattern or a non-wild type
10 pattern of LBP metabolism. A non-wild type pattern of LBP metabolism can result, e.g., from under-expression, over-expression, no expression, or a temporal, site or distribution change. Such a non-wild type pattern can result, e.g., from one or more mutations in the LBP gene, in a binding molecule gene, a regulatory gene, or in any other gene which directly or indirectly affects LBP metabolism. A mutation is meant to include, e.g., an alteration, e.g., in gross or fine
15 structure, in a nucleic acid. Examples include single base pair alterations, e.g., missense or nonsense mutations, frameshifts, deletions, insertions and translocations. Mutations can be dominant or recessive. Mutations can be homozygous or heterozygous. Preferably, an aspect of LBP-1, LBP-2 or LBP-3 metabolism is evaluated.

An agent is meant to include, e.g., any substance, e.g., an anti-atherosclerosis drug. The
20 agent of this invention preferably can change an aspect of LBP metabolism. Such change can be the result of any of a variety of events, including, e.g., preventing or reducing interaction between LBP and a binding molecule, e.g., LDL or an arterial extracellular matrix structural component; inactivating LBP and/or the binding molecule, e.g., by cleavage or other
modification; altering the affinity of LBP and the binding molecule for each other; diluting out
25 LBP and/or the binding molecule; preventing expression of LBP and/or the binding molecule; reducing synthesis of LBP and/or the binding molecule; synthesizing an abnormal LBP and/or binding molecule; synthesizing an alternatively spliced LBP and/or binding molecule; preventing or reducing proper conformational folding of LBP and/or the binding molecule; modulating the binding properties of LBP and/or the binding molecule; interfering with signals that are required
30 to activate or deactivate LBP and/or the binding molecule; activating or deactivating LBP and/or the binding molecule in such a way as to prevent binding; or interfering with other receptors, ligands or other molecules which are required for the normal synthesis or functioning of LBP

and/or the binding molecule. For example, the agent can block the binding site on LDL for LBPs expressed focally in the arterial wall extracellular matrix, or it could block the binding site on an LBP for LDL, or it could be bifunctional, i.e., it could block both binding sites.

Examples of agents include LBP polypeptide, e.g., LBP-1, LBP-2 or LBP-3, or a
5 biologically active fragment or analog thereof; a nucleic acid encoding LBP polypeptide or a biologically active fragment or analog thereof; a nucleic acid encoding an LBP regulatory sequence or a biologically active fragment or analog thereof; a binding molecule for LBP polypeptide; a binding molecule for LBP nucleic acid, the LBP nucleic acid being, e.g., a nucleic acid comprising a regulatory region for LBP or a nucleic acid comprising a structural region for
10 LBP or a biologically active fragment of LBP; an antisense nucleic acid; a mimetic of LBP or a binding molecule; an antibody for LBP or a binding molecule; a metabolite; or an inhibitory carbohydrate or glycoprotein. In certain embodiments, the agent is an antagonist, agonist or super agonist.

Knowledge of the existence of the sequence of the LBPs allows a search for natural or
15 artificial ligands to regulate LDL levels in the treatment of atherosclerosis. In certain embodiments, the agent is a natural ligand for LBP. In certain embodiments, the agent is an artificial ligand for LBP.

By analog is meant a compound that differs from naturally occurring LBP in amino acid sequence or in ways that do not involve sequence, or both. Analogs of the invention generally
20 exhibit at least about 80% homology, preferably at least about 90% homology, more preferably yet at least about 95% homology, and most preferably at least about 98% homology, with substantially the entire sequence of a naturally occurring LBP sequence, preferably with a segment of about 100 amino acid residues, more preferably with a segment of about 50 amino acid residues, more preferably yet with a segment of about 30 amino acid residues, more
25 preferably yet with a segment of about 20 amino acid residues, more preferably yet with a segment of about 10 amino acid residues, more preferably yet with a segment of about 5 amino acid residues, more preferably yet with a segment of about 4 amino acid residues, more preferably yet with a segment of about 3 amino acid residues, and most preferably with a segment of about 2 amino acid residues. Non-sequence modifications include, e.g., in vivo or in
30 vitro chemical derivatizations of LBP. Non-sequence modifications include, e.g., changes in phosphorylation, acetylation, methylation, carboxylation, or glycosylation. Methods for making such modifications are known to those skilled in the art. For example, phosphorylation can be

modified by exposing LBP to phosphorylation-altering enzymes, e.g., kinases or phosphatases.

Preferred analogs include LBP or biologically active fragments thereof whose sequences differ from the wild-type sequence by one or more conservative amino acid substitutions or by one or more non-conservative amino acid substitutions, deletions, or insertions which do not abolish LBP biological activity. Conservative substitutions typically include the substitution of one amino acid for another with similar characteristics, e.g., substitutions within the following groups: valine, glycine; glycine, alanine; valine, isoleucine, leucine; aspartic acid, glutamic acid; asparagine, glutamine; serine, threonine; lysine, arginine; and phenylalanine, tyrosine. Other examples of conservative substitutions are shown in Table 1.

Table 1

CONSERVATIVE AMINO ACID SUBSTITUTIONS

For Amino Acid	Code	Replace with any of
Alanine	A	D-Ala, Gly, beta-Ala, L-Cys, D-Cys
Arginine	R	D-Arg, Lys, D-Lys, homo-Arg, D-homo-Arg, Met, Ile, D-Met, D-Ile, Orn, D-Orn, L-NMMA, L-NAME
Asparagine	N	D-Asn, Asp, D-Asp, Glu, D-Glu, Gln, D-Gln
Aspartic Acid	D	D-Asp, D-Asn, Asn, Glu, D-Glu, Gln, D-Gln
Cysteine	C	D-Cys, S-Me-Cys, Met, D-Met, Thr, D-Thr
Glutamine	Q	D-Gln, Asn, D-Asn, Glu, D-Glu, Asp, D-Asp
Glutamic Acid	E	D-Glu, D-Asp, Asp, Asn, D-Asn, Gln, D-Gln
Glycine	G	Ala, D-Ala, Pro, D-Pro, β -Ala Acp
Histidine	H	D-His
Isoleucine	I	D-Ile, Val, D-Val, Leu, D-Leu, Met, D-Met
Leucine	L	D-Leu, Val, D-Val, Leu, D-Leu, Met, D-Met
Lysine	K	D-Lys, Arg, D-Arg, homo-Arg, D-homo-Arg, Met, D-Met, Ile, D-Ile, Orn, D-Orn
Methionine	M	D-Met, S-Me-Cys, Ile, D-Ile, Leu, D-Leu, Val, D-Val
Phenylalanine	F	D-Phe, Tyr, D-Thr, L-Dopa, His, D-His, Trp, D-Trp, Trans-3,4, or 5-phenylproline, cis-3,4, or 5-phenylproline
Proline	P	D-Pro, L-I-thioazolidine-4-carboxylic acid, D-or L-1-oxazolidine-4-carboxylic acid
Serine	S	D-Ser, Thr, D-Thr, allo-Thr, Met, D-Met, Met(O), D-Met(O), L-Cys, D-Cys
Threonine	T	D-Thr, Ser, D-Ser, allo-Thr, Met, D-Met, Met(O), D-Met(O), Val, D-Val
Tryptophan	W	D-Trp, Phe, D-Phe, Tyr, D-Tyr
Tyrosine	Y	D-Tyr, Phe, D-Phe, L-Dopa, His, D-His
Valine	V	D-Val, Leu, D-Leu, Ile, D-Ile, Met, D-Met

Amino acid sequence variants of a protein can be prepared by any of a variety of methods known to those skilled in the art. For example, random mutagenesis of DNA which encodes a protein or a particular domain or region of a protein can be used, e.g., PCR mutagenesis (using, e.g., reduced *Taq* polymerase fidelity to introduce random mutations into a cloned fragment of DNA; Leung et al., *BioTechnique* 1:11-15 (1989)), or saturation mutagenesis (by, e.g., chemical treatment or irradiation of single-stranded DNA in vitro, and synthesis of a complementary DNA strand; Mayers et al., *Science* 229:242 (1985)). Random mutagenesis can also be accomplished by, e.g., degenerate oligonucleotide generation (using, e.g., an automatic DNA synthesizer to chemically synthesize degenerate sequences; Narang, *Tetrahedron* 39:3 (1983); Itakura et al., *Recombinant DNA*, Proc. 3rd Cleveland Sympos. Macromolecules, ed. A.G. Walton, Amsterdam: Elsevier, pp. 273-289 (1981)). Non-random or directed mutagenesis can be used to provide specific sequences or mutations in specific regions. These techniques can be used to create variants which include, e.g., deletions, insertions, or substitutions, of residues of the known amino acid sequence of a protein. The sites for mutation can be modified individually or in series, e.g., by (i) substituting first with conserved amino acids and then with more radical choices depending upon results achieved, (ii) deleting the target residue, (iii) inserting residues of the same or a different class adjacent to the located site, or (iv) combinations of the above. For example, analogs can be made by in vitro DNA sequence modifications of the sequences of Figs. 10-18 (SEQ ID NOS:10-18). For example, in vitro mutagenesis can be used to convert any of these DNA sequences into a sequence which encodes an analog in which one or more amino acid residues has undergone a replacement, e.g., a conservative replacement as described in Table 1.

Methods for identifying desirable mutations include, e.g., alanine scanning mutagenesis (Cunningham and Wells, *Science* 244:1081-1085 (1989)), oligonucleotide-mediated mutagenesis (Adelman et al., *DNA* 2:183 (1983)); cassette mutagenesis (Wells et al., *Gene* 34:315 (1985)), combinatorial mutagenesis, and phage display libraries (Ladner et al., PCT International Appln. No. WO88/06630). The LBP analogs can be tested, e.g., for their ability to bind to LDL and/or to an arterial extracellular matrix component, as described herein.

Other analogs within the invention include, e.g., those with modifications which increase peptide stability. Such analogs may contain, e.g., one or more non-peptide bonds (which replace the peptide bonds) in the peptide sequence. Also included are, e.g.: analogs that include residues other than naturally occurring L-amino acids, e.g., D-amino acids or non-naturally occurring or synthetic amino acids, e.g., β or γ amino acids; and cyclic analogs.

Analogs are also meant to include peptides in which structural modifications have been introduced into the peptide backbone so as to make the peptide non-hydrolyzable. Such peptides are particularly useful for oral administration, as they are not digested. Peptide backbone modifications include, e.g., modifications of the amide nitrogen, the α -carbon, the amide carbonyl, or the amide bond, and modifications involving extensions, deletions or backbone crosslinks. For example, the backbone can be modified by substitution of a sulfoxide for the carbonyl, by reversing the peptide bond, or by substituting a methylene for the carbonyl group. Such modifications can be made by standard procedures known to those skilled in the art. See, e.g., Spatola, A.F., "Peptide Backbone Modifications: A Structure-Activity Analysis of Peptides Containing Amide Bond Surrogates, Conformational Constraints, and Related Backbone Replacements," in Chemistry and Biochemistry of Amino Acids, Peptides and Proteins, Vol. 7, pp. 267-357. B. Weinstein (ed.), Marcel Dekker, Inc., New York (1983).

An analog is also meant to include polypeptides in which one or more of the amino acid residues include a substituent group, or polypeptides which are fused with another compound, e.g., a compound to increase the half-life of the polypeptide, e.g., polyethylene glycol.

By fragment is meant some portion of the naturally occurring LBP polypeptide. Preferably, the fragment is at least about 100 amino acid residues, more preferably at least about 50 amino acid residues, more preferably yet at least about 30 amino acid residues, more preferably yet at least about 20 amino acid residues, more preferably yet at least about 5 amino acid residues, more preferably yet at least about 4 amino acid residues, more preferably yet at least about 3 amino acid residues, and most preferably at least about 2 amino acid residues in length. Fragments include, e.g., truncated secreted forms, proteolytic fragments, splicing fragments, other fragments, and chimeric constructs between at least a portion of the relevant gene, e.g., LBP-1, LBP-2 or LBP-3, and another molecule. Fragments of LBP can be generated by methods known to those skilled in the art. In certain embodiments, the fragment is biologically active. The ability of a candidate fragment to exhibit a biological activity of LBP can be assessed by methods known to those skilled in the art. For example, LBP fragments can be tested for their ability to bind to LDL and/or to an arterial extracellular matrix structural component, as described herein. Also included are LBP fragments containing residues that are not required for biological activity of the fragment or that result from alternative mRNA splicing or alternative protein processing events.

Fragments of a protein can be produced by any of a variety of methods known to those

skilled in the art, e.g., recombinantly, by proteolytic digestion, or by chemical synthesis. Internal or terminal fragments of a polypeptide can be generated by removing one or more nucleotides from one end (for a terminal fragment) or both ends (for an internal fragment) of a nucleic acid which encodes the polypeptide. Expression of the mutagenized DNA produces polypeptide
5 fragments. Digestion with "end-nibbling" endonucleases can thus generate DNAs which encode an array of fragments. DNAs which encode fragments of a protein can also be generated, e.g., by random shearing, restriction digestion or a combination of the above-discussed methods. For example, fragments of LBP can be made by expressing LBP DNA which has been manipulated in vitro to encode the desired fragment, e.g., by restriction digestion of any of the DNA
10 sequences of Figs. 10-18 (SEQ ID NOS:10-18).

Fragments can also be chemically synthesized using techniques known in the art, e.g., conventional Merrifield solid phase f-Moc or t-Boc chemistry. For example, peptides of the present invention can be arbitrarily divided into fragments of desired length with no overlap of the fragments, or divided into overlapping fragments of a desired length.

15 An LBP or a biologically active fragment or analog thereof, or a binding molecule or a biologically active fragment or analog thereof, can, e.g., compete with its cognate molecule for the binding site on the complementary molecule, and thereby reduce or eliminate binding between LBP and the cellular binding molecule. LBP or a binding molecule can be obtained, e.g., from purification or secretion of naturally occurring LBP or binding molecule, from
20 recombinant LBP or binding molecule, or from synthesized LBP or binding molecule.

Therefore, methods for generating analogs and fragments and testing them for activity are known to those skilled in the art.

An agent can also be a nucleic acid used as an antisense molecule. Antisense therapy is meant to include, e.g., administration or in situ generation of oligonucleotides or their derivatives
25 which specifically hybridize, e.g., bind, under cellular conditions, with the cellular mRNA and/or genomic DNA encoding an LBP polypeptide, or mutant thereof, so as to inhibit expression of the encoded protein, e.g., by inhibiting transcription and/or translation. The binding may be by conventional base pair complementarity, or, for example, in the case of binding to DNA duplexes, through specific interactions in the major groove of the double helix.

30 In certain embodiments, the antisense construct binds to a naturally-occurring sequence of an LBP gene which, e.g., is involved in expression of the gene. These sequences include, e.g., promoter, start codons, stop codons, and RNA polymerase binding sites.

In other embodiments, the antisense construct binds to a nucleotide sequence which is not present in the wild type gene. For example, the antisense construct can bind to a region of an LBP gene which contains an insertion of an exogenous, non-wild type sequence. Alternatively, the antisense construct can bind to a region of an LBP gene which has undergone a deletion, thereby bringing two regions of the gene together which are not normally positioned together and which, together, create a non-wild type sequence. When administered in vivo to a subject, antisense constructs which bind to non-wild type sequences provide the advantage of inhibiting the expression of a mutant LBP gene, without inhibiting expression of any wild type LBP gene.

An antisense construct of the present invention can be delivered, e.g., as an expression plasmid which, when transcribed in the cell, produces RNA which is complementary to at least a unique portion of the cellular mRNA which encodes an LBP polypeptide. An alternative is that the antisense construct is an oligonucleotide which is generated ex vivo and which, when introduced into the cell causes inhibition of expression by hybridizing with the mRNA (duplexing) and/or genomic sequences (triplexing) of an LBP gene. Such oligonucleotides are preferably modified oligonucleotides which are resistant to endogenous nucleases, e.g. exonucleases and/or endonucleases, and are therefore stable in vivo. Exemplary nucleic acid molecules for use as antisense oligonucleotides are phosphoramidate, phosphothioate, phosphorodithioates and methylphosphonate analogs of DNA and peptide nucleic acids (PNA). (See also U.S. Patents 5,176,996; 5,264,564; and 5,256,775). Additionally, general approaches to constructing oligomers useful in antisense therapy have been reviewed. (See, e.g., Van der Krol et al., Biotechniques 6:958-976, (1988); Stein et al., Cancer Res. 48:2659-2668 (1988)).

By mimetic is meant a molecule which resembles in shape and/or charge distribution LBP or a binding molecule. The mimetic can be a peptide or a non-peptide. Mimetics can act as therapeutic agents because they can, e.g., competitively inhibit binding of LBP to a binding molecule. By employing, e.g., scanning mutagenesis, e.g., alanine scanning mutagenesis, linker scanning mutagenesis or saturation mutagenesis, to map the amino acid residues of a particular LBP polypeptide involved in binding a binding molecule, peptide mimetics, e.g., diazepam or isoquinoline derivatives, can be generated which mimic those residues in binding to a binding molecule, and which therefore can inhibit binding of the LBP to a binding molecule and thereby interfere with the function of LBP. Non-hydrolyzable peptide analogs of such residues can be generated using, e.g., benzodiazepine (see, e.g., Freidinger et al., in Peptides: Chemistry and Biology, G.R. Marshall ed., ESCOM Publisher: Leiden, Netherlands (1988)); azepine (see, e.g.,

Huffman et al., in Peptides: Chemistry and Biology, G.R. Marshall ed., ESCOM Publisher: Leiden, Netherlands (1988)); substituted gamma lactam rings (see, e.g., Garvey et al., in Peptides: Chemistry and Biology, G.R. Marshall ed., ESCOM Publisher: Leiden, Netherlands (1988)); keto-methylene pseudopeptides (see, e.g., Ewenson et al., J. Med. Chem. 29:295 (1986));

5 Ewenson et al., in Peptides: Structure and Function (Proceedings of the 9th American Peptide Symposium) Pierce Chemical Co. Rockland, IL (1985)); β -turn dipeptide cores (see, e.g., Nagai et al., Tetrahedron Lett. 26:647 (1985); Sato et al., J. Chem. Soc. Perkin Trans. 1:1231 (1986)); or β -aminoalcohols (see, e.g., Gordon et al., Biochem. Biophys. Res. Commun. 126:419 (1985); Dann et al., Biochem. Biophys. Res. Commun. 134:71 (1986)).

10 Antibodies are meant to include antibodies against any moiety that directly or indirectly affects LBP metabolism. The antibodies can be directed against, e.g., LBP or a binding molecule, or a subunit or fragment thereof. For example, antibodies include anti-LBP-1, LBP-2 or LBP-3 antibodies; and anti-binding molecule antibodies. Antibody fragments are meant to include, e.g., Fab fragments, Fab' fragments, F(ab')₂ fragments, F(v) fragments, heavy chain

15 monomers, heavy chain dimers, heavy chain trimers, light chain monomers, light chain dimers, light chain trimers, dimers consisting of one heavy and one light chain, and peptides that mimic the activity of the anti-LBP or anti-binding molecule antibodies. For example, Fab₂' fragments of the inhibitory antibody can be generated through, e.g., enzymatic cleavage. Both polyclonal and monoclonal antibodies can be used in this invention. Preferably, monoclonal antibodies are

20 used. Natural antibodies, recombinant antibodies or chimeric-antibodies, e.g., humanized antibodies, are included in this invention. Preferably, humanized antibodies are used when the subject is a human. Most preferably, the antibodies have a constant region derived from a human antibody and a variable region derived from an inhibitory mouse monoclonal antibody.

Production of polyclonal antibodies to LBP is described in Example 6. Monoclonal and

25 humanized antibodies are generated by standard methods known to those skilled in the art. Monoclonal antibodies can be produced, e.g., by any technique which provides antibodies produced by continuous cell lines cultures. Examples include the hybridoma technique (Kohler and Milstein, Nature 256:495-497 (1975), the trioma technique, the human B-cell hybridoma technique (Kozbor et al., Immunology Today 4:72 (1983)), and the EBV-hybridoma technique to

30 produce human monoclonal antibodies (Cole et al., in Monoclonal Antibodies and Cancer Therapy, A.R. Liss, Inc., pp. 77-96 (1985)). Preferably, humanized antibodies are raised through conventional production and harvesting techniques (Berkower, I., Curr. Opin. Biotechnol. 7:622-

628 (1996); Ramharayan and Skaletsky, Am. Biotechnol. Lab 13:26-28 (1995)). In certain preferred embodiments, the antibodies are raised against the LBP, preferably the LDL-binding site, and the Fab fragments produced. These antibodies, or fragments derived therefrom, can be used, e.g., to block the LDL-binding sites on the LBP molecules.

5 Agents also include inhibitors of a molecule that are required for synthesis, post-translational modification, or functioning of LBP and/or a binding molecule, or activators of a molecule that inhibits the synthesis or functioning of LBP and/or the binding molecule. Agents include, e.g., cytokines, chemokines, growth factors, hormones, signaling components, kinases, phosphatases, homeobox proteins, transcription factors, editing factors, translation factors and
10 post-translation factors or enzymes. Agents are also meant to include ionizing radiation, non-ionizing radiation, ultrasound and toxic agents which can, e.g., at least partially inactivate or destroy LBP and/or the binding molecule.

An agent is also meant to include an agent which is not entirely LBP specific. For example, an agent may alter other genes or proteins related to arterial plaque formation. Such
15 overlapping specificity may provide additional therapeutic advantage.

The invention also includes the agent so identified as being useful in treating atherosclerosis.

The invention also includes a method for evaluating an agent for the ability to alter the binding of LBP polypeptide to a binding molecule. An agent is provided. An LBP polypeptide
20 is provided. A binding molecule is provided. The agent, LBP polypeptide and binding molecule are combined. The formation of a complex comprising the LBP polypeptide and binding molecule is detected. An alteration in the formation of the complex in the presence of the agent as compared to in the absence of the agent is indicative of the agent altering the binding of the LBP polypeptide to the binding molecule.

25 In preferred embodiments, the LBP polypeptide is LBP-1, LBP-2 or LBP-3. Examples of a binding molecule include native LDL, modified LDL, e.g., methylated LDL or oxidized LDL, and arterial extracellular matrix structural components.

Altering the binding includes, e.g., inhibiting or promoting the binding. The efficacy of the agent can be assessed, e.g., by generating dose response curves from data obtained using
30 various concentrations of the agent. Methods for determining formation of a complex are standard and are known to those skilled in the art, e.g., affinity coelectrophoresis (ACE) assays or ELISA assays as described herein.

The invention also includes the agent so identified as being able to alter the binding of an LBP polypeptide to a binding molecule.

The invention also includes a method for evaluating an agent for the ability to bind to an LBP polypeptide. An agent is provided. An LBP polypeptide is provided. The agent is
5 contacted with the LBP polypeptide. The ability of the agent to bind to the LBP polypeptide is evaluated. Preferably, the LBP polypeptide is LBP-1, LBP-2 or LBP-3. Binding can be determined, e.g., by measuring formation of a complex by standard methods known to those skilled in the art, e.g., affinity coelectrophoresis (ACE) assays or ELISA assays as described herein.

10 The invention also includes the agent so identified as being able to bind to LBP polypeptide.

The invention also includes a method for evaluating an agent for the ability to bind to a nucleic acid encoding an LBP regulatory sequence. An agent is provided. A nucleic acid encoding an LBP regulatory sequence is provided. The agent is contacted with the nucleic acid.
15 The ability of the agent to bind to the nucleic acid is evaluated. Preferably, the LBP regulatory sequence is an LBP-1, LBP-2 or LBP-3 regulatory sequence. Binding can be determined, e.g., by measuring formation of a complex by standard methods known to those skilled in the art, e.g., DNA mobility shift assays, DNase I footprint analysis (Ausubel et al., ed., Current Protocols in Molecular Biology, John Wiley & Sons, New York, NY, (1989)).

20 The invention also includes the agent so identified as being able to bind to a nucleic acid encoding an LBP regulatory sequence.

The invention also includes a method for treating atherosclerosis in an animal. An animal in need of treatment for atherosclerosis is provided. An agent capable of altering an aspect of LBP structure or metabolism is provided. The agent is administered to the animal in a
25 therapeutically effective amount such that treatment of the atherosclerosis occurs.

In certain preferred embodiments, the agent is an LBP polypeptide, e.g., LBP-1, LBP-2 or LBP-3, or a biologically active fragment or analog thereof. The agent can be, e.g., the polypeptide as set forth in SEQ ID NOS:1-9. Preferably, the agent is a polypeptide of no more than about 100 amino acid residues in length, more preferably of no more than about 50 amino
30 acid residues, more preferably yet of no more than about 30 amino acid residues, more preferably yet of no more than about 20 amino acid residues, more preferably yet of no more than about 10 amino acid residues, more preferably yet of no more than about 5 amino acid residues, more

preferably yet of no more than about 4 amino acid residues, more preferably yet of no more than about 3 amino acid residues, and most preferably of no more than about 2 amino acid residues. Preferably, the polypeptide includes at least about 20% acidic amino acid residues, more preferably yet at least about 40% acidic amino acid residues, more preferably yet at least about 60% acidic amino acid residues, more preferably yet at least about 80% acidic amino acid residues, more preferably yet at least about 90% acidic amino acid residues, more preferably yet at least about 95% acidic amino acid residues, and most preferably at least about 98% acidic amino acid residues. Acidic amino acid residues include aspartic acid and glutamic acid. An example of such an LBP polypeptide is BHF-1, which is a 20 amino acid length fragment of human or rabbit LBP-1 which contains amino acid residues 14 through 33. See Fig. 9 (SEQ ID NO:9). 45% of the amino acid residues of BHF-1 are acidic. The invention also includes biologically active fragments and analogs of BHF-1.

Other preferred acidic regions from the LBPs are amino acid residues 8 through 22 (SEQ ID NO:19), 8 through 33 (SEQ ID NO:20), 23 through 33 (SEQ ID NO:21), and 208 through 217 (SEQ ID NO:22) of human LBP-2 as depicted in Fig. 7 (SEQ. ID NO:7); amino acid residues 14 through 43 (SEQ ID NO:23) and 38 through 43 (SEQ ID NO:24) of rabbit or human LBP-1 as depicted in Fig. 1 (SEQ ID NO:1) and Fig. 6 (SEQ ID NO:6); amino acid residues 105 through 120 (SEQ ID NO:25), 105 through 132 (SEQ ID NO:26), 121 through 132 (SEQ ID NO:27), and 211 through 220 (SEQ ID NO:28) of rabbit LBP-2 as depicted in Fig. 2 (SEQ ID NO:2); amino acid residues 96 through 110 (SEQ ID NO:29) of rabbit LBP-3 as depicted in Fig. 5 (SEQ ID NO:5); and amino acid residues 53-59 (SEQ ID NO:41) of human LBP-3 as depicted in Fig. 8 (SEQ ID NO:8). The invention is also meant to include biologically active fragments and analogs of any of these polypeptides.

Other examples of agents include homopolymers and heteropolymers of any amino acid or amino acid analog. In certain preferred embodiments, the agent is a homopolymer of an acidic amino acid or analog thereof. In certain embodiments, the agent is a heteropolymer of one or more acidic amino acids and one or more other amino acids, or analogs thereof. For example, agents include poly(glu), poly(asp), poly(glu asp), poly(glu N), poly(asp N) and poly(glu asp N). By N is meant any amino acid, or analog thereof, other than glu or asp. By poly(glu asp) is meant all permutations of glu and asp for a given length peptide. A preferred peptide is poly(glu) of no more than about 10 amino acids in length, preferably about 7 amino acids in length.

In certain preferred embodiments, the agent is an LBP nucleic acid or a biologically active fragment or analog thereof, e.g., a nucleic acid encoding LBP-1, LBP-2 or LBP-3 polypeptide, or a biologically active fragment or analog thereof. The agent can be, e.g., a nucleic acid comprising a nucleotide sequence as set forth in SEQ ID NOS:10-18. In other
5 embodiments, the agent is an antisense molecule, e.g., one which can bind to an LBP gene sequence.

Treating is meant to include, e.g., preventing, treating, reducing the symptoms of, or curing the atherosclerosis. Administration of the agent can be accomplished by any method which allows the agent to reach the target cells. These methods include, e.g., injection,
10 deposition, implantation, suppositories, oral ingestion, inhalation, topical administration, or any other method of administration where access to the target cells by the agent is obtained. Injections can be, e.g., intravenous, intradermal, subcutaneous, intramuscular or intraperitoneal. Implantation includes inserting implantable drug delivery systems, e.g., microspheres, hydrogels, polymeric reservoirs, cholesterol matrices, polymeric systems, e.g., matrix erosion and/or
15 diffusion systems and non-polymeric systems, e.g., compressed, fused or partially fused pellets. Suppositories include glycerin suppositories. Oral ingestion doses can be enterically coated. Inhalation includes administering the agent with an aerosol in an inhalator, either alone or attached to a carrier that can be absorbed.

Administration of the agent can be alone or in combination with other therapeutic agents.
20 In certain embodiments, the agent can be combined with a suitable carrier, incorporated into a liposome, or incorporated into a polymer release system.

In certain embodiments of the invention, the administration can be designed so as to result in sequential exposures to the agent over some time period, e.g., hours, days, weeks, months or years. This can be accomplished by repeated administrations of the agent by one of
25 the methods described above, or alternatively, by a controlled release delivery system in which the agent is delivered to the animal over a prolonged period without repeated administrations. By a controlled release delivery system is meant that total release of the agent does not occur immediately upon administration, but rather is delayed for some time. Release can occur in bursts or it can occur gradually and continuously. Administration of such a system can be, e.g.,
30 by long acting oral dosage forms, bolus injections, transdermal patches or subcutaneous implants.

Examples of systems in which release occurs in bursts include, e.g., systems in which the

agent is entrapped in liposomes which are encapsulated in a polymer matrix, the liposomes being sensitive to a specific stimulus, e.g., temperature, pH, light, magnetic field, or a degrading enzyme, and systems in which the agent is encapsulated by an ionically-coated microcapsule with a microcapsule core-degrading enzyme. Examples of systems in which release of the agent is gradual and continuous include, e.g., erosional systems in which the agent is contained in a form within a matrix, and diffusional systems in which the agent permeates at a controlled rate, e.g., through a polymer. Such sustained release systems can be, e.g., in the form of pellets or capsules.

The agent can be suspended in a liquid, e.g., in dissolved form or colloidal form. The liquid can be a solvent, partial solvent or non-solvent. In many cases water or an organic liquid can be used.

The agent can be administered prior to or subsequent to the appearance of atherosclerosis symptoms. In certain embodiments, the agent is administered to patients with familial histories of atherosclerosis, or who have phenotypes that may indicate a predisposition to atherosclerosis, or who have been diagnosed as having a genotype which predisposes the patient to atherosclerosis, or who have other risk factors, e.g., hypercholesterolemia, hypertension or smoking.

The agent is administered to the animal in a therapeutically effective amount. By therapeutically effective amount is meant that amount which is capable of at least partially preventing or reversing atherosclerosis. A therapeutically effective amount can be determined on an individual basis and will be based, at least in part, on consideration of the species of animal, the animal's size, the animal's age, the agent used, the type of delivery system used, the time of administration relative to the onset of atherosclerosis symptoms, and whether a single, multiple, or controlled release dose regimen is employed. A therapeutically effective amount can be determined by one of ordinary skill in the art employing such factors and using no more than routine experimentation.

Preferably, the concentration of the agent is at a dose of about 0.1 to about 1000 mg/kg body weight/day, more preferably at about 0.1 to about 500 mg/kg/day, more preferably yet at about 0.1 to about 100 mg/kg/day, and most preferably at about 0.1 to about 5 mg/kg/day. The specific concentration partially depends upon the particular agent used, as some are more effective than others. The dosage concentration of the agent that is actually administered is dependent at least in part upon the final concentration that is desired at the site of action, the

method of administration, the efficacy of the particular agent, the longevity of the particular agent, and the timing of administration relative to the onset of the atherosclerosis symptoms. Preferably, the dosage form is such that it does not substantially deleteriously affect the animal. The dosage can be determined by one of ordinary skill in the art employing such factors and
5 using no more than routine experimentation.

In certain embodiments, various gene constructs can be used as part of a gene therapy protocol to deliver nucleic acids encoding an agent, e.g., either an agonistic or antagonistic form of an LBP polypeptide. For example, expression vectors can be used for in vivo transfection and expression of an LBP polypeptide in particular cell types so as to reconstitute the function of, or
10 alternatively, abrogate the function of, LBP polypeptide in a cell in which non-wild type LBP is expressed. Expression constructs of the LBP polypeptide, and mutants thereof, may be administered in any biologically effective carrier, e.g. any formulation or composition capable of effectively delivering the LBP gene to cells in vivo. Approaches include, e.g., insertion of the subject gene in viral vectors including, e.g., recombinant retroviruses, adenovirus, adeno-
15 associated virus, and herpes simplex virus-1, or recombinant bacterial or eukaryotic plasmids. Viral vectors infect or transduce cells directly; plasmid DNA can be delivered with the help of, for example, cationic liposomes (lipofectin™ (Life Technologies, Inc., Gaithersburg, MD) or derivatized (e.g. antibody conjugated), polylysine conjugates, gramicidin S, artificial viral envelopes or other such intracellular carriers, as well as direct injection of the gene construct or
20 $\text{Ca}_3(\text{PO}_4)_2$ precipitation carried out in vivo. The above-described methods are known to those skilled in the art and can be performed without undue experimentation. Since transduction of appropriate target cells represents the critical first step in gene therapy, choice of the particular gene delivery system will depend on such factors as the phenotype of the intended target and the route of administration, e.g., locally or systemically. Administration can be directed to one or
25 more cell types, and to one or more cells within a cell type, so as to be therapeutically effective, by methods that are known to those skilled in the art. In a preferred embodiment, the agent is administered to arterial wall cells of the animal. For example, a genetically engineered LBP gene is administered to arterial wall cells. In certain embodiments, administration is done in a prenatal animal or embryonic cell. It will be recognized that the particular gene construct
30 provided for in in vivo transduction of LBP expression is also useful for in vitro transduction of cells, such as for use in the diagnostic assays described herein.

In certain embodiments, therapy of atherosclerosis is performed with antisense nucleotide analogs of the genes which code for the LBPs. Preferably, the antisense nucleotides have non-hydrolyzable "backbones," e.g., phosphorothioates, phosphorodithioates or methylphosphonates. The nucleoside base sequence is complementary to the sequence of a portion of the gene coding for, e.g., LBP-1, 2 or 3. Such a sequence might be, e.g., ATTGGC if the gene sequence for the LBP is TAACCG. One embodiment of such therapy would be incorporation of an antisense analog of a portion of one of the LBP genes in a slow-release medium, e.g., polyvinyl alcohol, which is administered, e.g., by subcutaneous injection, so as to release the antisense nucleotide analog over a period of weeks or months. In another embodiment, the antisense analog is incorporated into a polymeric matrix, e.g., polyvinyl alcohol, such that the gel can be applied locally to an injured arterial wall to inhibit LBP synthesis and prevent LDL accumulation, e.g., after angioplasty or atherectomy.

The invention also includes a method for treating an animal at risk for atherosclerosis. An animal at risk for atherosclerosis is provided. An agent capable of altering an aspect of LBP structure or metabolism is provided. The agent is administered to the animal in a therapeutically effective amount such that treatment of the animal occurs. Being at risk for atherosclerosis can result from, e.g., a family history of atherosclerosis, a genotype which predisposes to atherosclerosis, or phenotypic symptoms which predispose to atherosclerosis, e.g., having hypercholesterolemia, hypertension or smoking.

The invention also includes a method for treating a cell having an abnormality in structure or metabolism of LBP. A cell having an abnormality in structure or metabolism of LBP is provided. An agent capable of altering an aspect of LBP structure or metabolism is provided. The agent is administered to the cell in a therapeutically effective amount such that treatment of the cell occurs.

In certain embodiments, the cell is obtained from a cell culture or tissue culture or an embryo fibroblast. The cell can be, e.g., part of an animal, e.g., a natural animal or a non-human transgenic animal. Preferably, the LBP is LBP-1, LBP-2 or LBP-3.

The invention also includes a pharmaceutical composition for treating atherosclerosis in an animal comprising a therapeutically effective amount of an agent, the agent being capable of altering an aspect of LBP metabolism or structure in the animal so as to result in treatment of the atherosclerosis, and a pharmaceutically acceptable carrier. Pharmaceutically acceptable carriers include, e.g., saline, liposomes and lipid emulsions.

In certain preferred embodiments, the agent of the pharmaceutical composition is an LBP polypeptide, e.g., LBP-1, LBP-2 or LBP-3, or a biologically active fragment or analog thereof. The agent can be, e.g., the polypeptide as set forth in SEQ ID NOS:1-9. Preferably, the agent is a polypeptide of no more than about 100 amino acid residues in length, more preferably of no more than about 50 amino acid residues, more preferably yet of no more than about 30 amino acid residues, more preferably yet of no more than about 20 amino acid residues, more preferably yet of no more than about 10 amino acid residues, more preferably yet of no more than about 5 amino acid residues, more preferably yet of no more than about 4 amino acid residues, more preferably yet of no more than about 3 amino acid residues, and most preferably of no more than about 2 amino acid residues. Preferably, the polypeptide includes at least about 20% acidic amino acid residues, more preferably yet at least about 40% acidic amino acid residues, more preferably yet at least about 60% acidic amino acid residues, more preferably yet at least about 80% acidic amino acid residues, more preferably yet at least about 90% acidic amino acid residues, more preferably yet at least about 95% acidic amino acid residues, and most preferably at least about 98% acidic amino acid residues.

In certain preferred embodiments, the agent is an LBP nucleic acid, e.g., a nucleic acid encoding LBP-1, LBP-2 or LBP-3 polypeptide, or a biologically active fragment or analog thereof. The agent can be, e.g., a nucleic acid comprising a nucleotide sequence as set forth in SEQ ID NOS:10-18.

The invention also includes a vaccine composition for treating atherosclerosis in an animal comprising a therapeutically effective amount of an agent, the agent being capable of altering an aspect of LBP metabolism or structure in the animal so as to result in treatment of the atherosclerosis, and a pharmaceutically acceptable carrier.

The invention also includes a method for diagnosing atherosclerotic lesions in an animal. An animal is provided. A labeled agent capable of binding to LBP present in atherosclerotic lesions is provided. The labeled agent is administered to the animal under conditions which allow the labeled agent to interact with the LBP so as to result in labeled LBP. The localization or quantification of the labeled LBP is determined by imaging so as to diagnose the presence of atherosclerotic lesions in the animal.

Preferably, the LBP is LBP-1, LBP-2 or LBP-3. The imaging can be performed by standard methods known to those skilled in the art, including, e.g., magnetic resonance imaging, gamma camera imaging, single photon emission computed tomographic (SPECT) imaging, or

positron emission tomography (PET).

Preferably, agents that bind tightly to LBPs in atherosclerotic lesions are used for atherosclerotic imaging and diagnosis. The agent is radiolabeled with, e.g., ^{99m}Tc or another isotope suitable for clinical imaging by gamma camera, SPECT, PET scanning or other similar technology. Since LBPs occur in very early lesions, such imaging is more sensitive than angiography or ultrasound for locating very early lesions which do not yet impinge on the arterial lumen to cause a visible bulge or disturbed flow. In addition to locating both early and more developed lesions, the imaging agents which bind to LBPs can also be used to follow the progress of atherosclerosis, as a means of evaluating the effectiveness of both dietary and pharmacological treatments.

Thus, a diagnostic embodiment of the invention is the adaptation of, e.g., a peptide complementary to one of the LBPs, by radiolabeling it and using it as an injectable imaging agent for detection of occult atherosclerosis. The peptide is selected from those known to bind to LBPs, e.g., RRRRRRR or KKLKLXX, or any other polycationic peptide which binds to the highly electronegative domains of the LBPs. For extracorporeal detection with a gamma scintillation (Anger) camera, technetium-binding ligands, e.g., CGC, GGCGC, or GGCGCF, can be incorporated into the peptides at the N-terminus or C-terminus for ^{99m}Tc labeling. For external imaging by magnetic resonance imaging (MRI), e.g., the gadolinium-binding chelator, diethylene triamine penta-acetic acid (DTPA), is covalently bound to the N- or C-terminus of the peptides. In yet other embodiments, the LBP-binding peptides are covalently bound, e.g., to magnetic ion oxide particles by standard methods known to those skilled in the art, e.g., conjugating the peptides with activated polystyrene resin beads containing magnetic ion oxide.

The invention also includes a method for immunizing an animal against an LBP, e.g., LBP-1, LBP-2 or LBP-3, or fragment or analog thereof. An animal having LDL is provided. An LBP or fragment or analog thereof is provided. The LBP or fragment or analog thereof is administered to the animal so as to stimulate antibody production by the animal to the LBP or fragment or analog thereof such that binding of the LBP to the LDL is altered, e.g., decreased or increased.

The invention also includes a method of making a fragment or analog of LBP polypeptide, the fragment or analog having the ability to bind to modified LDL and native LDL. An LBP polypeptide is provided. The sequence of the LBP polypeptide is altered. The altered LBP polypeptide is tested for the ability to bind to modified LDL, e.g., methylated LDL,

oxidized LDL, acetylated LDL, cyclohexanedione-treated LDL (CHD-LDL), and to native LDL.

The fragments or analogs can be generated and tested for their ability to bind to these modified LDLs and to native LDL, by methods known to those skilled in the art, e.g., as described herein. Preferably, they are tested for their ability to bind to methylated LDL and
5 native LDL. The binding activity of the fragment or analog can be greater or less than the binding activity of the native LBP. Preferably, it is greater. In preferred embodiments, the LBP is LBP-1, LBP-2 or LBP-3.

The invention also includes a method for isolating a cDNA encoding an LBP. A cDNA library is provided. The cDNA library is screened for a cDNA encoding a polypeptide which
10 binds to native LDL and modified LDL, e.g., methylated LDL or oxidized LDL. The cDNA which encodes this polypeptide is isolated, the cDNA encoding an LBP.

The following non-limiting examples further illustrate the present invention.

EXAMPLES

15 Example 1: Construction of a Rabbit cDNA Library

This example illustrates the construction of a rabbit cDNA library using mRNA from balloon-deendothelialized healing rabbit abdominal aorta. Balloon-catheter deendothelialized rabbit aorta has been shown to be a valid model for atherosclerosis (Minick et al., Am. J. Pathol. 95:131-158 (1979)).

20 The mRNA was obtained four weeks after ballooning to maximize focal LDL binding in the ballooned rabbit aorta. First strand cDNA synthesis was carried out in a 50 µl reaction mixture containing 4 µg mRNA; 2 µg oligo d(T) primer; methylation dNTP mix (10 mM each); 10 mM DTT; 800 units superscript II RT (Life Technologies, Gaithersburg, MD); 1 X first strand cDNA synthesis buffer (50 mM Tris-HCl, pH 8.3; 75 mM KCl; 5 mM MgCl₂), which was
25 incubated for 1 hr at 37°C. The reaction mixture was then adjusted to 250 µl through the addition of 1 X second strand buffer (30 mM Tris-HCl, pH 7.5; 105 mM KCl; 5.2 mM MgCl₂); 0.1 mM DTT; methylation dNTP mix (10 mM each); 50 units *E. coli* DNA polymerase I, 3 units RNase H; 15 units *E. coli* DNA ligase (all enzymes from Life Technologies), which was incubated for an additional 2.5 hr at 15°C. The resulting double-stranded cDNAs (dscDNA)
30 were then treated with 1.5 units T4 DNA polymerase (Novagen Inc., Madison, WI) for 20 min at 11°C to make blunt-ended dscDNA. These were then concentrated by ethanol precipitation and EcoRI/Hind III linkers were attached to the ends by T4 DNA ligase (Novagen Inc.). The linker-ligated cDNAs were treated with EcoRI and HindIII restriction enzymes to produce EcoRI and

Hind III recognition sequences at their 5' and 3' ends, respectively. After the removal of linker DNA by gel exclusion chromatography, the dscDNAs were inserted into λ EXlox phage arms (Novagen Inc.) in a unidirectional manner by T4 DNA ligase and packaged into phage particles according to the manufacturer's protocol (Novagen Inc.). A phage library of cDNAs containing 2 x 10⁶ independent clones was established from 4 μ g of mRNA.

Example 2: Identification of Rabbit cDNAs Encoding LDL Binding Proteins (LBPs)

This example illustrates a method of functionally screening a rabbit cDNA library so as to identify cDNAs encoding LBPs which bind to both native LDL and methyl LDL. Methyl LDL is not recognized by previously reported cell surface receptors. See, e.g., Weisgraber et al., J. Biol. Chem. 253:9053-9062 (1978).

A fresh overnight culture of *E. coli* ER1647 cells (Novagen Inc.) was infected with the cDNA phage obtained from Example 1, and plated at a density of 2 x 10⁴ plaque-forming units (pfu) in 150 mm diameter plates containing 2 X YT agar. A total of 50 plates, equivalent to 1 x 10⁶ phage, were plated and incubated at 37°C until the plaques reached 1 mm in diameter (5-6 hr). A dry nitrocellulose membrane, which had previously been saturated with 10 mM IPTG solution, was layered on top of each plate to induce the production of recombinant protein, as well as to immobilize the proteins on the membranes. The plates were incubated at 37°C for an additional 3-4 hr, and then overnight at 4°C.

The next day, the membranes were lifted from each plate and processed as follows. Several brief rinses in TBST solution (10mM Tris-HCl, pH 8.0; 150mM NaCl, 0.05% Tween 20); two 10-min rinses with 6M guanidine-HCl in HBB (20mM HEPES, pH 7.5; 5mM MgCl₂, 1mM DTT, and 5mM KCl); two 5-min rinses in 3M guanidine-HCl in HBB; a final brief rinse in TBSEN (TBS, 1mM EDTA, 0.02% NaN₃).

The membranes were then blocked for 30 min at room temperature in a solution of TBSEN with 5% non-fat dry milk, followed by 10 min in TBSEN with 1% non-fat dry milk. Following blocking, the membranes were incubated with native human LDL (obtained as described in Example 11 or methylated human LDL (meLDL) (see Weisgraber et al., J. Biol. Chem. 253:9053-9062 (1978)), at a concentration of 4 μ g/ml, in a solution containing 1 X TBSEN, 1% non-fat dry milk, 1mM PMSF, 0.5 X protease inhibitor solution (1mM ϵ -amino caproic acid/1mM benzamidine). Incubation was for 4 hr at room temperature in a glass Petri dish with gentle stirring on a stirring table, followed by overnight at 4°C with no stirring.

Specifically bound meLDL and native LDL were detected on the nitrocellulose membranes by antibodies against human LDL. Sheep anti-human LDL polyclonal antibodies (Boehringer Mannheim, Indianapolis, IN) were adsorbed with *E. coli* phage E cell extracts to abolish background. For adsorption, *E. coli* phage E cells were grown to log phase, spun down and resuspended in PBS containing 1 mM PMSF, 2 mM ϵ -amino caproic acid, and 1 mM benzamidine. The cell suspension then underwent 8 freeze-thaw cycles via immersion in liquid nitrogen and cold running tap water, respectively. The anti LDL antibodies/cell extract solution were incubated with gentle stirring for 1 hr at 4°C (1 ml of antibody solution/3 mg crude cell extract). Following incubation, the mixture was centrifuged (10,000 x g; 10 min; 4°C) and the supernatant was stored at 4°C in the presence of 0.02% NaN₃ until use. The membranes were processed for immunoscreening as follows: (i) three 5-min washes at room temperature in TBSEN containing 1% gelatin; (ii) 30 min incubation in PBS, pH 7.4 with 1% gelatin; (iii) two-hr room temperature incubation with gentle stirring in fresh PBS/gelatin solution containing adsorbed sheep anti-human LDL antibodies (Boehringer Mannheim, Indianapolis, IN) (1:1000 dilution); (iv) three brief washes in TBS, pH 7.4; (v) one-hr room temperature incubation with gentle stirring in PBS/gelatin solution containing donkey antiship alkaline phosphatase-conjugated antibodies (Sigma, St. Louis, MO) (1:10,000 dilution); (vi) three brief washes with TBS, pH 7.4.; and (vii) development according to the manufacturer's instructions, using an alkaline phosphatase substrate development kit (Novagen Inc.). Phage plaques which produced LBPs appeared as blue-colored "donuts" on the membranes.

The phage from Example 1 containing the LBP cDNAs were plaque-purified and converted into plasmid subclones by following a protocol called "Autosubcloning by Cre-mediated Plasmid Excision" provided by Novagen Inc. DNA sequences were obtained by the dideoxynucleotide chain-termination method (Sanger et al., Proc. Natl. Acad. Sci., USA 74:5463-5467 (1977), and analyzed by an Applied Biosystems automated sequencer. The open reading frame (ORF) of each cDNA was determined from consensus sequences obtained from both the sense and antisense strands of the cDNAs. Sequencing confirmed that three previously unknown genes had been isolated. Since the genes were selected by functional screening for LDL binding, the proteins coded by these genes were termed LDL binding proteins (LBPs), specifically, LBP-1, LBP-2 and LBP-3. The cDNA sequences for rabbit LBP-1, LBP-2 and LBP-3 and the corresponding proteins are set forth in SEQ ID NOS:10-14.

Based on their respective cDNA coding sequences, the sizes of the recombinant proteins were determined to be 16.2 kDa for LBP-1, 40 kDa for LBP-2, and 62.7 kDa for LBP-3.

Example 3: Northern Blot Analysis of Rabbit RNA Using LBP cDNA or cRNA

5 This example illustrates the size and tissue distribution of LBP mRNAs. Total RNA was isolated from different rabbit tissues: adrenals, thoracic aorta, abdominal aorta, ballooned and reendothelialized abdominal aorta, heart, kidney, smooth muscle cells, lung and liver, by Trizol reagent (Life Technologies) and concentrated by ethanol precipitation. Gel electrophoresis of RNA was carried out in 1.2% agarose gel containing 1 X MOPS buffer (0.2M MOPS, pH 7.0; 10 50mM sodium acetate; 5mM EDTA, pH 8.0) and 0.37M formaldehyde. Gels were loaded with 20 µg total RNA from each tissue examined and electrophoresed at 100 volts for 2 hr in 1 X MOPS buffer. RNAs were blotted onto supported nitrocellulose membranes (Schleicher & Schuell, Keene, NH) and immobilized by baking at 80°C for 2 hr. Hybridization to radiolabeled LBP-1, LBP-2 and LBP-3 cDNA or cRNA probes was carried out by standard procedures known 15 to those skilled in the art (see, e.g., Ausubel et al., Current Protocols in Molecular Biology; John Wiley & Sons (1989)); signals were detected by autoradiography.

The results were as follows: the sizes of the mRNAs were about 1.3 kb for LBP-1, about 2.3-2.5 kb for LBP-2, and about 4.7 kb for LBP-3. LBP-1, LBP-2 and LBP-3 mRNA were found in all tissues tested, but the highest amount was in ballooned abdominal aorta.

20

Example 4: Isolation of Human LBP cDNAs

This example illustrates isolation of human LBP cDNAs. Human LBP cDNA clones were isolated from three cDNA libraries. A human fetal brain cDNA library was obtained from Stratagene, LaJolla, CA, a human liver and a human aorta cDNA library were obtained from 25 Clontech, Palo Alto, CA, and screened with a radiolabeled cDNA probe derived from rabbit LBP-1, LBP-2 or LBP-3, according to the method described in Law et al., Gene Expression 4:77-84 (1994). Several strongly hybridizing clones were identified and plaque-purified. Clones were confirmed to be human LBP-1, LBP-2 and LBP-3, by DNA sequencing using the dideoxynucleotide chain-termination method and analysis by an Applied Biosystems automated 30 sequencer. The cDNA sequences and the corresponding proteins for human LBP-1, LBP-2 and LBP-3 are set forth in SEQ ID NOS:15, 16 and 17, respectively. A comparison between the corresponding LBP-1, LBP-2 and LBP-3 protein sequences for rabbit and human are shown in Figs. 19, 20 and 21.

Example 5: Isolation of Recombinant LBP-1, LBP-2 and LBP-3 Rabbit Proteins from E. coli

LBP cDNA was isolated from the original pEXlox plasmids obtained as described in Examples 1 and 2, and subcloned into the pPROEX-HT vector (Life Technologies) for recombinant protein expression. Induction of the recombinant protein by IPTG addition to transformed *E. coli* DH10B cultures resulted in the expression of recombinant protein containing a 6-histidine tag (N-terminal). This tagged protein was then purified from whole cell proteins by binding to Ni-NTA (nickel nitrilo-triacetic acid) as described in the protocol provided by the manufacturer (Qiagen, Inc., Santa Clara, CA). The preparation obtained after the chromatography step was approximately 90% pure; preparative SDS-PAGE was performed as the final purification step.

When required by the characterization procedure, iodination of LBPs was carried out using Iodobeads (Pierce, Rockford, IL). The Iodobeads were incubated with 500 μ Ci of Na^{125}I solution (17 Ci/mg) (New England Nuclear, Boston, MA) in a capped microfuge tube for 5 min at room temperature. The protein solution was added to the Iodobeads- Na^{125}I microfuge tube and incubated for 15 min at room temperature. At the end of this incubation, aliquots were removed for the determination of total soluble and TCA precipitable counts. The radiolabeled protein was then precipitated with cold acetone (2.5 vol; -20°C ; 2.5 hr). Following this incubation, precipitated protein was collected by centrifugation (14,000 g; 1 hr; room temperature) and resuspended in sample buffer (6 M urea/50 mM Tris, pH 8.0/2 mM EDTA). Integrity of the protein preparation was assessed by SDS-PAGE.

The identities of the recombinant LBPs were confirmed using standard protein sequencing protocols known to those skilled in the art. (A Practical Guide for Protein and Peptide Purification for Microsequencing, Matsudaira, ed., Academic Press, Inc., 2d edition (1993)). Analysis was performed using an Applied Biosystems Model 477A Protein Sequencer with on-line Model 120 PTH amino acid analyzer.

Example 6: Production of Antibodies to LBP-1, LBP-2 and LBP-3

This example illustrates the production of polyclonal antibodies to LBP-1, LBP-2 and LBP-3. A mixture of purified recombinant LBP protein (0.5 ml; 200 μ g) and RIBI adjuvant (RIBI ImmunoChem Research, Inc., Hamilton, MT) was injected subcutaneously into male guinea pigs (Dunkin Hartley; Hazelton Research Products, Inc., Denver, PA) at 3-5 sites along the dorsal thoracic and abdominal regions of the guinea pig. Blood was collected by

venipuncture on days 1 (pre-immune bleeding), 28, 49 and 70. Booster injections were administered on days 21 (100 µg; SC), 42 (50 µg; SC), and 63 (25 µg; SC). The titer of the guinea pig antiserum was evaluated by serial dilution "dot blotting." Preimmune antiserum was evaluated at the same time. After the third booster of LBP protein, the titer against the recombinant protein reached a maximal level with a detectable colorimetric response on a dot blot assay of 156 pg.

Specificity of the polyclonal antibody for recombinant LBP-1, LBP-2 or LBP-3 was demonstrated using Western blot analysis. (Towbin et al., Proc. Natl. Acad. Sci. USA 76:4350 (1979)). The protein-antibody complex was visualized immunochemically with alkaline phosphatase-conjugated goat anti-guinea pig IgG, followed by staining with nitro blue tetrazolium (BioRad Laboratories, Hercules, CA). Non-specific binding was blocked using 3% non-fat dry milk in Tris buffered saline (100 mM Tris; 0.9% NaCl, pH 7.4).

Example 7: Immunohistochemical Characterization

This example illustrates the presence of LBPs in or on endothelial cells covering plaques, in or on adjacent smooth muscle cells, and in the extracellular matrix. In addition, co-localization of LDL and LBPs was demonstrated. These results were obtained by examining ballooned rabbit arterial lesions and human atherosclerotic plaques by immunohistochemical methods.

Ballooned deendothelialized aorta was obtained from rabbits which had received a bolus injection of human LDL (3 mg; i.v.) 24 hr prior to tissue collection. Human aortas containing atherosclerotic plaques were obtained from routine autopsy specimens. Tissues were fixed in 10% buffered formalin (≤ 24 hr) and imbedded in paraffin using an automated tissue-imbedding machine. Tissue sections were cut (5-7 µ) and mounted onto glass slides by incubating for 1 hr at 60°C. Sections were deparaffinized. After a final wash with deionized H₂O, endogenous peroxidase activity was eliminated by incubating the sections with 1% H₂O₂/H₂O buffer for 5 min at room temperature. Sections were rinsed with phosphate buffered saline (PBS) for 5 min at room temperature and nonspecific binding was blocked with 5% normal goat serum or 5% normal rabbit serum depending on the source of the secondary antibody (Sigma, St. Louis, MO) (1 hr; room temperature). Sections were then incubated with a 1:50 dilution (in 5% normal goat serum/PBS) of a guinea pig polyclonal antibody against the rabbit form of recombinant LBP-1, LBP-2 or LBP-3. Controls included preimmune serum as well as specific antisera to LBP-1,

LBP-2, or LBP-3 in which the primary antibody was completely adsorbed and removed by incubation with recombinant LBP-1, LBP-2 or LBP-3 followed by centrifugation prior to incubation with the tissue sections. An affinity purified rabbit polyclonal antibody against human apolipoprotein B (Polysciences Inc.; Warrington, PA) was used at a dilution of 1:100 (in 5% normal rabbit serum/PBS). Sections were incubated for 2 hr at room temperature in a humidified chamber. At the end of incubation, sections were rinsed with PBS and incubated with a 1:200 dilution (in 5% normal goat serum/PBS) of goat anti-guinea pig biotinylated IgG conjugate (Vector Laboratories, Burlingame, CA) or a 1:250 dilution (in 5% normal rabbit serum/PBS) of rabbit anti-goat biotinylated IgG conjugate (Vector Laboratories, Burlingame, CA) for 1 hr at room temperature in a humidified chamber. Sections were then rinsed with PBS and antigen-antibody signal amplified using avidin/biotin HRP conjugate (Vectastain ABC kit; Vector Laboratories, Burlingame, CA). Sections were developed using DAB substrate (4-6 min; room temperature) and counterstained with hematoxylin.

In the ballooned rabbit artery, immunohistochemistry with the anti-LBP-1, LBP-2 and LBP-3 antibodies showed that LBP-1, LBP-2 and LBP-3 were located in or on functionally modified endothelial cells at the edges of regenerating endothelial islands, the same location in which irreversible LDL binding has been demonstrated (Chang et al., *Arteriosclerosis and Thrombosis* 12:1088-1098 (1992)). LBP-1, LBP-2 and LBP-3 were also found in or on intimal smooth muscle cells underneath the functionally modified endothelial cells, and to a lesser extent, in extracellular matrix. No LBP-1, LBP-2 or LBP-3 was detected in still deendothelialized areas, where LDL binding had been shown to be reversible (Chang et al., *Arteriosclerosis and Thrombosis* 12:1088-1098 (1992)). Immunohistochemistry of ballooned rabbit aorta with anti-human apolipoprotein B antibodies showed the presence of LDL at the same locations as that found for LBP-1, LBP-2 and LBP-3.

In the human atherosclerotic plaques taken at routine autopsies, immunohistochemistry with the anti-LBP-1, anti-LBP-2 and anti-LBP-3 antibodies showed that LBP-1, LBP-2, and LBP-3 were also found in or on endothelial cells covering plaques and in or on adjacent smooth muscle cells. In the human tissue, there was greater evidence of LBP-1, LBP-2 and LBP-3 in extracellular matrix.

The results obtained with paraffin sections were identical to those of frozen sections.

Example 8: Affinity Coelectrophoresis (ACE) Assays of LBPs and LDL or HDL

This example illustrates that binding occurs between LBP-1, LBP-2 or LBP-3 and LDL, and that this binding is specific, as illustrated by the fact that binding does not occur between
5 LBP-1, LBP-2 or LBP-3 and HDL (high density lipoprotein).

Analysis of the affinity and specificity of recombinant rabbit LBP-1, LBP-2 or LBP-3 binding to LDL was carried out using the principle of affinity electrophoresis (Lee and Lander, Proc. Natl. Acad. Sci. USA 88:2768-2772 (1991)). Melted agarose (1%; 65°C) was prepared in 50 mM sodium MOPS, pH 7.0; 125 mM sodium acetate, 0.5% CHAPS. A teflon comb
10 consisting of nine parallel bars (45 x 4 x 4 mm/3 mm spacing between bars) was placed onto GelBond film (FMC Bioproducts, Rockland, ME) fitted to a plexiglass casting tray with the long axis of the bars parallel to the long axis of the casting tray. A teflon strip (66 x 1 x 1 mm) was placed on edge with the long axis parallel to the short axis of the casting tray, at a distance of 4 mm from the edge of the teflon comb. Melted agarose (>65°C) was then poured to achieve a
15 height of approximately 4 mm. Removal of the comb and strip resulted in a gel containing nine 45 x 4 x 4 mm rectangular wells adjacent to a 66 x 1 mm slot. LDL or HDL samples were prepared in gel buffer (50mM sodium MOPS, pH 7.0, 125 mM sodium acetate) at twice the desired concentration. Samples were then mixed with an equal volume of melted agarose (in 50 mM MOPS, pH 7.0; 125 mM sodium acetate; 50°C), pipetted into the appropriate rectangular
20 wells and allowed to gel. The binding affinity and specificity of LBP-1 and LBP-3 was tested using several concentrations of LDL (540 to 14 nM) and HDL (2840-177 nM). A constant amount (0.003 nM - 0.016 nM) of ¹²⁵I-labeled LBP-1, LBP-2 or LBP-3 (suspended in 50 mM sodium MOPS, pH 7.0; 125 mM sodium acetate; 0.5% bromphenol blue; 6% (wt/vol) sucrose) was loaded into the slot. Gels were electrophoresed at 70v/2hr/20°C. At the end of the run, the
25 gels were air dried and retardation profiles were visualized by exposure of X-ray films to the gels overnight at -70°C, with intensifying screens).

LDL retarded LBP-1, LBP-2 and LBP-3 migration through the gel in a concentration-dependent, saturable manner, indicating that LBP-1, LBP-2 and LBP-3 binding to LDL was highly specific. This conclusion is supported by the fact that HDL did not retard LBP-1, LBP-2
30 or LBP-3. A binding curve generated from the affinity coelectrophoresis assay indicated that LBP-1 binds to LDL with a K_d of 25.6 nM, that LBP-2 (rabbit clone 26) binds to LDL with a K_d of 100 nM, and that LBP-3 (80 kDa fragment) binds to LDL with a K_d of 333 nM.

In addition to testing affinity and specificity of LBP-1, LBP-2 and LBP-3 binding to

LDL, the ability of "cold" (i.e., non-radiolabeled) LBP-1, LBP-2 or LBP-3 to competitively inhibit radiolabeled LBP-1, LBP-2 or LBP-3 binding to LDL, respectively, was tested.

Competition studies were carried out using fixed concentrations of cold LDL and radiolabeled LBP-1 and increasing amounts of cold recombinant LBP-1 (6-31 μ M). The ACE assay samples and gel were prepared as described herein. Cold LBP-1 inhibited binding of radiolabeled LBP-1 to LDL in a concentration-dependent manner, cold LBP-2 inhibited binding of radiolabeled LBP-2 to LDL in a concentration-dependent manner, and cold LBP-3 inhibited binding of radiolabeled LBP-3 to LDL in a concentration-dependent manner.

Rabbit and human LBP-2 contain a long stretch of acidic amino acids at the amino terminal (rabbit LBP-2 amino acid residues 105 through 132 and human LBP-2 amino acid residues 8 through 33). The possibility that this segment of LBP-2 was the LDL binding domain was tested by subcloning two rabbit LBP-2 clones which differ from each other by the presence or absence of this acidic region (clone 26 and clone 45, respectively) into expression vectors, by standard methods known to those skilled in the art. ACE assays were then conducted in order to assess the affinity and specificity of the binding of these two clones to LDL. LDL retarded clone 26 derived radiolabeled LBP-2 migration through the gel in a concentration-dependent, saturable, manner while clone 45 derived radiolabeled LBP-2 migration was not retarded.

Competition studies using fixed concentrations of cold LDL and clone 26 derived radiolabeled LBP-2 and increasing concentrations of cold recombinant LBP-2/clone 26 and LBP-2/clone 45 were carried out. Cold clone 26 derived LBP-2 inhibited binding of clone 26 derived radiolabeled LBP-2 to LDL in a concentration-dependent manner. Clone 45 derived LBP-2, on the other hand, did not affect the binding of clone 26 derived radiolabeled LBP-2 to LDL. These results indicate that the long stretch of acidic amino acids contain a binding domain of LBP-2 to LDL.

Example 9: Affinity Coelectrophoresis (ACE) Assays of LBP-1 or LBP-2 and LDL in the Presence of Inhibitors

This example illustrates that binding between LBP-1 or LBP-2 and LDL is inhibited by polyglutamic acid or BHF-1. The ability of a third compound to inhibit binding between two proteins previously shown to interact was tested by a modification of the ACE assays described in Example 8. The third compound was added to the top or wells together with the radiolabeled protein. If the third compound inhibited binding, the radiolabeled protein would run through the

gel. If the third compound did not inhibit binding, migration of the radio-labeled protein was retarded by the protein cast into the gel.

Inhibition of LBP-1/LDL or LBP-2/LDL binding by polyglutamic acid (average MW about 7500, corresponding to about 7 monomers) was shown by casting a constant amount of LDL (148 nM) in all the rectangular lanes. A constant amount (1 μ l) of 125 I-labeled LBP-1 or LBP-2 (0.003 nM - 0.016 nM) was loaded in the wells at the top of the gel, together with increasing concentrations of polyglutamic acid (obtained from Sigma) (0-0.4 nM). The gel was electrophoresed at 70 volts for 2 hr, dried and placed on X-ray film, with intensifying screens, overnight at -70°C before the film was developed to determine the retardation profile of LBP-1 and LBP-2. As the concentration of polyglutamic acid increased, retardation of radiolabeled LBP-1 and LBP-2 migration by LDL decreased in a concentration-dependent manner, which showed that polyglutamic acid inhibited binding between LBP-1, LBP-2 and LDL.

Inhibition of LBP-1/LDL binding by BHF-1 was shown by casting a constant amount of LDL (148 nM) in all the rectangular lanes. A constant amount of 125 I-labeled LBP-1 (0.003 nM - 0.016 nM) was loaded in the wells at the top of the gel, together with increasing concentrations of BHF-1 (0-10 nM), obtained as described in Example 15. The gel was electrophoresed at 70 volts for 2 hr, dried and placed on X-ray film, with intensifying screens, overnight at -70°C. The film was then developed to determine the retardation profile of 125 I-LBP-1. As the concentration of BHF-1 increased, retardation of LBP-1 by LDL decreased in a concentration-dependent manner, which demonstrated that BHF-1 inhibited binding between LBP-1 and LDL.

Example 10: Affinity Coelectrophoresis (ACE) Assays for Identifying Fragments, Analogs and Mimetics of LBPs which Bind to LDL

This example illustrates a method for identifying fragments, analogs or mimetics of LBPs which bind to LDL, and which thus can be used as inhibitors of LDL binding to LBP in the arterial walls, by occupying binding sites on LDL molecules, thereby rendering these sites unavailable for binding to LBP in the arterial wall.

Fragments of LBPs are generated by chemical cleavage or synthesized from the known amino acid sequences. Samples of these fragments are individually added (cold) to radiolabeled LBP as described in Example 8, to assess the inhibitory potency of the various fragments. By iterative application of this procedure on progressively smaller portions of fragments identified as inhibitory, the smallest active polypeptide fragment or fragments are identified. In a similar

manner, analogs of the LBPs are tested to identify analogs which can act as inhibitors by binding to LDL. And, similarly, mimetics of LBP (molecules which resemble the conformation and/or charge distributions of the LDL-binding sites on LBP molecules) are tested in a similar fashion to identify molecules exhibiting affinities for the LDL-binding sites on LBP.

5 The affinities of the inhibitors so identified are at least as strong as the affinity of LDL itself for the LDL-binding sites on LBP. The inhibitors bind at least competitively, and some irreversibly and preferentially as well, to the LDL-binding sites, thereby rendering such sites unavailable for binding to humoral LDL.

10 Example 11: ELISA Assays

This example illustrates the use of an ELISA plate assay for the quantification of a test compound's capacity to inhibit the binding of LDL to a specific LBP.

The assay was carried out as follows: LDL was diluted in 50 mM Na₂HCO₃, pH 9.6/0.02% NaN₃ and added to the wells of a 96-well plate (ImmunoWare 96-Well Reacti-Bind
15 EIA Polystyrene Plates; Pierce (Rockford, IL)) to achieve a final concentration ranging from 0.1 to 1 µg/well. The plates were incubated for 6 hr at room temperature. At the end of the incubation period, the wells were washed 3 times with Tris-buffered saline, pH 7.4 (TBS), and blocked overnight with 200 µl of 1% bovine serum albumin (BSA) in TBS/0.02% NaN₃ (Sigma; St. Louis MO) at room temperature. The wells were then incubated with 200 µl of LBP protein
20 (5-10 µg/well) in TBS and varying concentrations of the test compound. Plates were incubated for 1 hr at room temperature. The wells were then washed three times with TBS and blocked for 2 hr with 200 µl of 1% BSA in TBS/0.02% NaN₃ at room temperature. At the end of the incubation period, the wells were washed 3 times with TBS and a 1:1000 dilution (in TBS/0.05% Tween 20) of the appropriate guinea pig anti-LBP protein polyclonal antibody was added to the
25 wells and incubated for 1 hr at room temperature. The wells were then washed 3 times with TBS/0.05% Tween 20; a 1:30,000 dilution of goat anti-guinea pig IgG alkaline phosphatase conjugate (Sigma) was added to each well. Plates were incubated for 1 hr at room temperature. The wells were washed 3 times with TBS/0.05% Tween 20 and a colorimetric reaction was carried out by adding 200 µl of p-nitrophenyl phosphate substrate (Sigma; St. Louis MO) to the
30 wells. The reaction was allowed to proceed for 30 min at room temperature and stopped with 50 µl of 3N NaOH. The absorbance was determined at 405 nm using an ELISA plate reader. The test compound's effectiveness in blocking the binding of LDL to the recombinant protein was

assessed by comparing the absorbance values of control and treated groups.

Alternatively, LBPs, rather than LDL, were bound to the plate. Recombinant LBP protein binding to LDL and the effect of varying concentration of the inhibitor on LBP-LDL binding was determined through the use of antibodies against LDL. This interaction was
5 visualized through the use of a secondary antibody conjugated to a reporter enzyme (e.g. alkaline phosphatase).

ELISA plate assays were used to screen agents which can affect the binding of LBP proteins to LDL. For example, peptides derived from LBP-1 and human LBP-3 protein sequences (BHF-1 and BHF-2, respectively) were synthesized and have been shown to reduce
10 the binding of LDL to recombinant LBP-1 and LBP-2 in this format. These results were in agreement with those obtained with the ACE assays.

Example 12: Administration of Humanized Antibodies Against LBPs so as to Block LDL-Binding Sites on the LBPs

15 This example illustrates administration to patients of humanized antibodies against LBP-1, LBP-2 or LBP-3 so as to block LDL-binding sites on arterial LBP molecules. Mouse monoclonal antibodies are humanized by recombinant DNA techniques and produced by standard procedures known to those skilled in the art (Berkower, I., Curr. Opin. Biotechnol.
20 7:622-628 (1996); Ramharayan and Skaletsky, Am. Biotechnol. Lab 13:26-28 (1995)) against LBPs and/or the LDL-binding sites on the LBPs. The corresponding Fab fragments are also produced, as described in Goding, J.W., Monoclonal Antibodies: Principles and Practice, Academic Press, New York, NY (1986). These antibodies are administered parenterally in sufficient quantity so as to block LDL-binding sites on the LBP molecules, i.e., 1-10 mg/kg
25 daily. This prevents the irreversible arterial uptake of LDL that is required to facilitate oxidation of the LDL.

Example 13: Preparation of LDL

This example illustrates the preparation of LDL. LDL was prepared from the plasma of
30 normolipemic donors (Chang et al., Arterioscler. Thromb. 12:1088-1098 (1992)). 100 ml of whole blood was placed into tubes containing 100 mM disodium EDTA. Plasma was separated from red blood cells by low-speed centrifugation (2,000 g; 30 min; 4°C). Plasma density was adjusted to 1.025 gm/ml with a solution of KBr and centrifuged for 18-20 hr, 100,000 x g, 12°C.

Very low density lipoproteins (VLDL) were removed from the tops of the centrifuge tubes with a Pasteur pipet. The density of the infranate was raised to 1.050 gm/ml with KBr solution and centrifuged for 22-24 hr, 100,000 x g, 12°C. LDL was removed from the tops of the centrifuge tubes with a drawn out Pasteur pipet tip. Purity of the LDL preparation was checked by

5 Ouchterlony double immunodiffusion against antibodies to human LDL, human HDL, human immunoglobulins, and human albumin. KBr was removed from the LDL solution by dialysis (1L, x 2, ≈ 16 hr) against 0.9% saline, pH 9.0, containing 1 mM EDTA and 10 μM butylated hydroxytoluene (BHT), the latter to prevent oxidation of LDL. Following dialysis, LDL protein was measured by the method of Lowry (Lowry et al., J. Biol. Chem. 193:265-275 (1951)), and

10 the LDL was stored at 4°C until use. LDL preparations were kept for no more than 4-6 weeks.

Example 14: Preparation of HDL

This example illustrates the preparation of HDL. HDL was prepared from plasma of normolipemic donors. 100 ml of whole blood was placed into tubes containing 100 mM

15 disodium EDTA and plasma was collected by centrifugation (2000 g; 30 min; 4°C). Apolipoprotein B containing lipoproteins present in plasma were then precipitated by the sequential addition of sodium heparin (5,000 units/ml) and MnCl₂ (1M) to achieve a final concentration of 200 units/ml and 0.46 M, respectively (Warnick and Albers, J. Lipid Res. 19:65-76 (1978)). Samples were then centrifuged (2000 g; 1 hr; 4°C). The supernatant was

20 collected and density adjusted to 1.21 g/ml by the slow addition of solid KBr. HDL was separated by ultracentrifugation (100,000 g; >46 hr; 12°C). Purity of the HDL preparation was assessed via Ouchterlony double immunodiffusion test using antibodies against human HDL, human LDL, human immunoglobulins, and human albumin. HDL samples were dialyzed against saline pH 9.0/1mM EDTA/10μM BHT (4L; 24 hr/4°C) and total protein was determined

25 by the Lowry protein assay (Lowry et al., J. Biol. Chem. 193:265-275 (1951)). HDL was stored at 4°C until use. HDL preparations were kept for no longer than 2 weeks.

Example 15: Synthesis of BHF-1

This example illustrates the synthesis of BHF-1, a fragment of human or rabbit LBP-1

30 which contains amino acid residues 14 through 33. BHF-1 was synthesized using an Applied Biosystems Model 430A peptide synthesizer with standard T-Boc NMP chemistry cycles. The sequence of BHF-1 is as follows:

val-asp-val-asp-glu-tyr-asp-glu-asn-lys-phe-val-asp-glu-
glu-asp-gly-gly-asp-gly (SEQ ID NO:9)

After synthesis, the peptide was cleaved with hydrofluoric acid/anisole (10/1 v/v) for 30 min at -
5 10°C and then incubated for 30 min at 0°C. BHF-1 was then precipitated and washed three
times with cold diethyl ether. Amino acid coupling was monitored with the ninhydrin test
(>99%).

The BHF-1 peptide was purified to homogeneity by high performance liquid
chromatography on a reverse phase Vydac C₄ column (2.24 X 25 cm) using a linear gradient
10 separation (2-98% B in 60 min) with a flow rate of 9 ml/min. Buffer A consisted of 0.1%
trifluoroacetic acid (TFA)/Milli Q water and Buffer B consisted of 0.085% TFA/80%
acetonitrile. The gradient was run at room temperature and absorbance monitored at 210 and 277
nm.

Fast atom bombardment-mass spectrometry gave a protonated molecular ion peak
15 (M+H)⁺ at m/z= 2290.2, in good agreement with the calculated value. On amino acid analysis,
experimental values for the relative abundance of each amino acid in the peptide were in good
agreement with theoretical values. The lyophilized peptide was stored at -20°C.

20 Example 16: In Vitro Screening for Agents Which Inhibit Binding Between LDL and LBPs

This example illustrates in vitro screening for agents which inhibit binding between LDL
and LBPs.

A candidate polypeptide for being an agent is chosen, e.g., LBP-1, LBP-2, LBP-3, BHF-1
or any other polypeptide. The shortest fragment of the polypeptide that inhibits LDL binding to
25 LBPs in vitro is determined. Peptides are synthesized by standard techniques described herein.
Inhibition assays are performed using standard ELISA techniques for screening, and affinity
coelectrophoresis (ACE) assays to confirm the ELISA results, as described herein. Short
peptides ranging, e.g., from dimers to 20-mers are constructed across sequences of the candidate
polypeptide whose chemical characteristics make them likely LDL binding sites, e.g., acidic
30 regions. The ability of shorter and shorter lengths of the peptides to inhibit LDL binding in vitro
and to mammalian cells in culture is tested. For example, the effect of the peptide on inhibiting
LDL binding in mammalian cells transfected to express an LBP gene is tested. Each of the
peptides so identified as an inhibitor is tested with each of LBP-1, LBP-2 and LBP-3, to

determine whether a single inhibitor works against all three LBPs.

Once the minimum active sequence is determined, the peptide backbone is modified so as to inhibit proteolysis, as discussed herein. For example, modification is accomplished by substitution of a sulfoxide for the carbonyl, by reversing the peptide bond, by substituting a methylene for the carbonyl group, or other similar standard methodology. See Spatola, A.F., "Peptide Backbone Modifications: A Structure-Activity Analysis of Peptides Containing Amide Bond Surrogates, Conformational Constraints, and Related Backbone Replacements," in Chemistry and Biochemistry of Amino Acids, Peptides and Proteins, Vol. 7, pp. 267-357, B. Weinstein (ed.), Marcel Dekker, Inc., New York (1983). The ability of these analogs to inhibit LDL binding to the LBPs in vitro is tested by ELISA and ACE assays in a similar manner as for the natural peptides described above.

Example 17: In Vitro Screening With Cultured Mammalian Cells for Agents Which Inhibit Binding Between LDL and LBPs

This example illustrates cell-based in vitro screening of agents which have been shown by in vitro tests such as ACE assay and ELISA to be potential inhibitors of binding between LDL and LBPs.

Mammalian cells, such as 293 cells, which are commonly used for expression of recombinant gene constructs, are used to develop cell lines which express LBPs on the cell surface. This is done by subcloning LBP open reading frames (ORFs) into a mammalian expression plasmid vector, pDisplay (Invitrogen, Carlsbad, CA), which is designed to express the gene of interest on the cell surface. The use of mammalian cells to produce LBPs allows for their expression in a functionally active, native conformation. Therefore, stably transfected mammalian cell lines with surface expression of LBPs individually, or in combination, are particularly suitable for assaying and screening inhibitors that block LDL binding in cell culture, as well as to evaluate the cytotoxicity of these compounds.

Specifically, LBP ORFs are amplified by PCR (Perkin Elmer, Foster City, CA) from cDNA templates using Taq polymerase (Perkin Elmer) and appropriate primers. The amplified LBP ORFs are purified by agarose gel electrophoresis and extracted from gel slices with the Bio-Rad DNA Purification kit (Bio-Rad, Hercules, CA). The purified DNAs are then cut with the restriction enzymes Bgl II and Sal I (New England Biolabs, Beverly, MA) to generate cohesive ends, and purified again by agarose gel electrophoresis and DNA extraction as described above.

The LBP ORFs are then subcloned into the Bgl II/Sal I sites in the mammalian expression vector, pDisplay (Invitrogen) by ligation. Recombinant plasmids are established by transformation in *E.coli* strains TOP10 (Invitrogen) or DH5 α (Life Technologies, Grand Island, NY). Recombinant pDisplay/LBP plasmid DNA is isolated from overnight *E.coli* cultures with the Bio-Rad Plasmid Miniprep kit, cut with Bgl II/Sal I, and analyzed by agarose gel electrophoresis. LBP ORFs in successfully transformed clones are verified by automated dideoxy DNA sequencing. To transfect human kidney 293 cells, 1-2 μ g of DNA is mixed with 6 μ l lipofectamine reagent (Life Technologies) and incubated with the cells as described in the Life Technologies protocol. LBP expression in transfected cells is confirmed by Western blot analysis of cell extracts obtained 48 hr after transfection. To select for stably transfected 293 cells, the antibiotic G418 (Life Technologies) is added to the growth medium at a concentration of 800 μ g/ml. Colonies resistant to G418 are tested for recombinant LBP expression by Western blot, and recombinant clones expressing LBPs are expanded, assayed for LDL binding and used to test compounds for their ability to inhibit LDL binding.

Example 18: In Vivo Screening for Agents Which Inhibit Binding Between LDL and LBPs

This example illustrates in vivo screening of agents which have been shown by in vitro tests to be promising candidate inhibitors of binding between LDL and LBPs.

In vivo inhibitory activity is first tested in the healing balloon-catheter deendothelialized rabbit aorta model of arterial injury (Roberts et al., J. Lipid Res. 24:1160-1167 (1983); Chang et al., Arterioscler. Thomb. 12:1088-1098 (1992)). This model was shown to be an excellent analog for human atherosclerotic lesions. Each candidate inhibitor is tested in five to ten ballooned rabbits, while an equal number of rabbits receive a control peptide, or placebo. Four weeks following aortic deendothelialization, when reendothelialization (healing) is partially complete, daily parenteral (intravenous or subcutaneous) or intragastric administration of the peptides and the analogs begins at an initial concentration of 10 mg/kg body weight, which is varied down, or up to 100 mg/kg depending on results. 30 min later, a bolus of intravenously injected 125 I (or 99m Tc-) labeled LDL is given to test the candidate inhibitor's ability in short term studies to inhibit LDL sequestration in healing arterial lesions. If 125 I-LDL is used, the animals are sacrificed 8-24 hr later, the aortas excised, washed and subjected to quantitative autoradiography of excised aortas, as previously described (Roberts et al., J. Lipid Res. 24:1160-1167 (1983); Chang et al., Arterioscler. Thomb. 12:1088-1098 (1992)). If 99m Tc-LDL is used,

analysis is by external gamma camera imaging of the live anesthetized animal at 2-24 hr, as previously described (Lees and Lees, Syndromes of Atherosclerosis, in Fuster, ed., Futura Publishing Co., Armonk, NY, pp. 385-401 (1996)), followed by sacrifice, excision and imaging of the excised aorta. Immediately before the end of testing, the animals have standard toxicity tests, including CBC, liver enzymes, and urinalysis.

The compounds which are most effective and least toxic are then tested in short term studies of rabbits fed a 2% cholesterol diet (Schwenke and Carew, Arteriosclerosis 9:895-907 (1989)). Each candidate inhibitor is tested in five to ten rabbits, while an equal number of rabbits receive a control peptide, or placebo. Animals receive one or more doses per day of the candidate inhibitor, or placebo, for up to two weeks. Daily frequency of doses is determined by route of administration. If active drug or placebo are administered parenterally, they are given 1-3 times daily and the 2% cholesterol diet is continued. If drug or placebo are given orally, they are mixed with the 2% cholesterol diet. Schwenke and Carew (Arteriosclerosis 9:895-907 (1989)) have shown that the LDL concentration in lesion-prone areas of the rabbit aorta is increased 22-fold above normal in rabbits fed a 2% cholesterol diet for 16 days, and that the increased LDL content precedes the histological evidence of early atherosclerosis. Therefore, analysis of the effect of the candidate inhibitors is tested two weeks after the start of cholesterol feeding by injecting ^{125}I -LDL, allowing it to circulate for 8-24 hr, and then performing quantitative autoradiography on the excised aortas of both test and control animals. If appropriate, quantitation of aortic cholesterol content is also carried out (Schwenke and Carew, Arteriosclerosis 9:895-907 (1989); Schwenke and Carew, Arteriosclerosis 9:908-918 (1989)).

The above procedures identify the most promising candidate inhibitors, as well as the best route and frequency of their administration. Inhibitors so identified are then tested in long-term studies of cholesterol-fed rabbits. These tests are carried out in the same way as the short-term cholesterol feeding studies, except that inhibitor effectiveness is tested by injection of ^{125}I -LDL at longer intervals following the initiation of cholesterol feeding, and lesion-prone areas of the aorta are examined histologically for evidence of atherosclerosis. Testing times are at two, four, and six months. Major arteries are examined grossly and histologically for evidence and extent of atherosclerosis. If necessary, other accepted animal models, such as atherosclerosis-susceptible primates (Williams et al., Arterioscler. Thromb. Vasc. Biol. 15:827-836 (1995)) and/or Watanabe rabbits are tested with short- and long-term cholesterol feeding.

Example 19: In Vivo Inhibition of Radiolabeled LDL Accumulation in the Ballooned Deendothelialized Rabbit Aorta via Induction of Active Immunity Against LBP Protein

5 This example illustrates the effect that induction of immunity against LBP protein has on the accumulation of radiolabeled LDL in the ballooned deendothelialized rabbit aorta model of atherosclerosis.

Immunity was induced in male New Zealand White rabbits (Hazelton Research Products, Denver, PA) as follows: A mixture of purified human recombinant LBP-2 or BHF-1 peptide (1
10 ml; 1 mg) and RIBI adjuvant (RIBI ImmunoChem Research, Inc., Hamilton, MT) was injected subcutaneously at 2-5 sites along the dorsal thoracic and abdominal regions of the rabbits. Blood was collected by venipuncture on days 1 (preimmune bleeding), 35, 63, and 91. Booster injections were administered on days 28 (500 µg; SC), 56 (250 µg; SC), and 84 (125 µg; SC).

The titer of the rabbits was evaluated by serial dilution using an ELISA plate format.
15 Preimmune serum was evaluated at the same time. After the third booster of LBP protein or peptide, the titer reached a maximal level with a detectable colorimetric response on an ELISA plate of 156 pg. Titer is defined as the maximum dilution of antibody which generates an absorbance reading of 0.5 above control in 30 min. Specificity of the polyclonal antibodies was demonstrated using Western blot analysis as described in Example 6.

20 On day 93, the abdominal aorta of immunized and control rabbits was deendothelialized using a Fogarty number 4 embolectomy catheter (Chang et al., Arteriosclerosis and Thrombosis 12:1088-1098 (1992)). Four weeks after ballooning, rabbits received a bolus injection of ¹²⁵I-labeled LDL (1 ml; i.v.). Blood samples were collected at 1 hr intervals for 8 hr, and 24 hr post injection. Blood samples were centrifuged for 30 min at 2000 rpm (40°C) and total activity
25 present in the serum was determined using a Gamma counter. Total TCA precipitable counts were determined by addition of TCA to the serum to a final concentration of 10% followed by incubation for 10 min at 4°C. Serum samples were then centrifuged (2000 rpm; 30 min; 40°C) and total activity present in the supernate was determined. TCA precipitable counts were calculated by substraction: total soluble counts minus counts present in the supernate after TCA
30 precipitation. Blood samples for the determination of antibody titers were collected prior to the injection of the radiolabeled LDL.

After 24 hr, the rabbits were injected intravenously with 5% Evan's blue dye which was allowed to circulate for 15 min. Areas of the aorta in which the endothelial covering is absent stain blue while those areas covered by endothelium remain unstained. At the end of the

incubation period, the rabbits were euthanized and the abdominal and thoracic aorta were dissected out, rinsed, and fixed overnight in 10% TCA at room temperature. The aortas were then rinsed exhaustively with physiological saline, weighed, counted, blotted dry and placed onto X-ray film in order to visualize the pattern of radiolabeled LDL accumulation in the
5 deendothelialized rabbit abdominal aorta.

Immunization of rabbits against recombinant human LBP-2 or BHF-1 peptide altered the pattern of radiolabeled LDL accumulation in the ballooned deendothelialized abdominal aorta. When corrected for dosage, and percent reendothelialization, immunized-ballooned rabbits had lower accumulation of radiolabeled LDL compared to
10 nonimmune-ballooned rabbits. These results indicate that active immunization against LBP provides an effective means by which the accumulation of LDL in the injured arterial wall can be modified.

15 Example 20: Screening Agents in Humans Which Inhibit Binding Between LDL and LBPs

Human studies are carried out according to standard FDA protocols for testing of new drugs for safety (Phase I), efficacy (Phase II), and efficacy compared to other treatments (Phase III). Subjects, who are enrolled into studies after giving informed consent, are between the ages of 18 and 70. Women who are pregnant, or likely to become pregnant, or subjects with diseases
20 other than primary atherosclerosis, such as cancer, liver disease, or diabetes, are excluded. Subjects selected for study in FDA Phase II and Phase III trials have atherosclerotic disease previously documented by standard techniques, such as ultrasound and/or angiography, or are known to be at high risk of atherosclerosis by virtue of having at least one first degree relative with documented atherosclerosis. Subjects themselves have normal or abnormal plasma lipids.
25 Initial testing includes 20-50 subjects on active drug and 20-50 subjects, matched for age, sex, and atherosclerotic status, on placebo. The number of subjects is pre-determined by the number needed for statistical significance. Endpoints for inhibitor efficacy includes ultrasound measurements of carotid artery thickness in high risk subjects, as well as in subjects with known carotid or coronary disease; atherosclerotic events; atherosclerotic deaths; and all-cause deaths in
30 all subjects. Non-invasive analysis (carotid artery thickness by ultrasound) as per Stadler (Med. and Biol. 22:25-34 (1996)) are carried out at 6- to 12-month intervals for 3 years. Atherosclerotic events and deaths, as well as all-cause deaths are tabulated at 3 years.

Oral dosage of drug in FDA Phase I trials ranges from 0.01 to 10 gm/day, and is

determined by results of animal studies, extrapolated on a per kg basis. Based on data obtained from Phase I studies, the dose range and frequency are narrowed in Phase II and III trials. If parenteral administration of drug is determined by animal studies to be the only effective method, parenteral administration in human subjects is tested by injection, as well as by the transdermal and nasal insufflation routes. Testing of parenteral drug follows the same outline as that for oral administration.

The optimal treatment schedule and dosage for humans is thus established.

Example 21: Treating an Individual Having Atherosclerosis with BHF-1

This example illustrates a method for treating an individual having atherosclerosis with an LBP fragment, e.g., BHF-1, so as to decrease the levels of arterially bound LDL in the individual. BHF-1 is obtained as described herein. The BHF-1 is administered to the mammal intravenously as a bolus or as an injection at a concentration of 0.5-10 mg/kg body weight. Such administrations are repeated indefinitely in order to prevent the development or progression of symptomatic atherosclerosis, just as is done currently with cholesterol-lowering drugs. Stable subjects are examined twice yearly to evaluate the extent of any atherosclerotic disease by physical exam and non-invasive studies, such as carotid artery thickness, ultrasound, and/or gamma camera imaging of the major arteries, to determine if atherosclerotic lesions are present, and, if previously present, have regressed or progressed. Such a regimen results in treatment of the atherosclerosis.

Those skilled in the art will be able to ascertain using no more than routine experimentation, many equivalents of the specific embodiments of the invention described herein. These and all other equivalents are intended to be encompassed by the following claims.

SEQUENCE LISTING

(1) GENERAL INFORMATION:

(i) APPLICANT: Lees, Ann M.

Lees, Robert S.

Law, Simon W.

Arjona, Anibal A.

(ii) TITLE OF INVENTION: NOVEL LOW DENSITY LIPOPROTEIN BINDING
PROTEINS AND THEIR USE IN DIAGNOSING AND TREATING
ATHEROSCLEROSIS

(iii) NUMBER OF SEQUENCES: 42

(iv) CORRESPONDENCE ADDRESS:

(A) ADDRESSEE: Banner & Witcoff, Ltd.

(B) STREET: One Financial Center

(C) CITY: Boston

(D) STATE: MA

(E) COUNTRY: USA

(F) ZIP: 02111

(v) COMPUTER READABLE FORM:

(A) MEDIUM TYPE: Floppy disk

(B) COMPUTER: IBM PC compatible

(C) OPERATING SYSTEM: PC-DOS/MS-DOS

(D) SOFTWARE: PatentIn Release #1.0, Version #1.30 and WordPerfect 6.1

(vi) CURRENT APPLICATION DATA:

(A) APPLICATION NUMBER: Not available

(B) FILING DATE: November 26, 1997

(C) CLASSIFICATION: Not available

(viii) ATTORNEY/AGENT INFORMATION:

(A) NAME: Greer, Helen

(B) REGISTRATION NUMBER: 36,816

(C) REFERENCE/DOCKET NUMBER: 3983/59819

(ix) TELECOMMUNICATION INFORMATION:

(A) TELEPHONE: 617-345-9100

(B) TELEFAX: 617-345-9111

(2) INFORMATION FOR SEQ ID NO:1:

(i) SEQUENCE CHARACTERISTICS:

(A) LENGTH: 151 amino acids

(B) TYPE: amino acid

(D) TOPOLOGY: linear

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:1:

```

Met Ser Lys Asn Thr Val Ser Ser Ala Arg Phe Arg Lys Val Asp Val
1           5           10           15
Asp Glu Tyr Asp Glu Asn Lys Phe Val Asp Glu Glu Asp Gly Gly Asp
20           25           30
Gly Gln Ala Gly Pro Asp Glu Gly Glu Val Asp Ser Cys Leu Arg Gln
35           40           45
Gly Asn Met Thr Ala Ala Leu Gln Ala Ala Leu Lys Asn Pro Pro Ile
50           55           60
Asn Thr Arg Ser Gln Ala Val Lys Asp Arg Ala Gly Ser Ile Val Leu
65           70           75           80
Lys Val Leu Ile Ser Phe Lys Ala Gly Asp Ile Glu Lys Ala Val Gln
85           90           95
Ser Leu Asp Arg Asn Gly Val Asp Leu Leu Met Lys Tyr Ile Tyr Lys
100          105          110
Gly Phe Glu Ser Pro Ser Asp Asn Ser Ser Ala Val Leu Leu Gln Trp
115          120          125
His Glu Lys Ala Leu Ala Ala Gly Gly Val Gly Ser Ile Val Arg Val
130          135          140
Leu Thr Ala Arg Lys Thr Val
145          150

```

(2) INFORMATION FOR SEQ ID NO:2:

(i) SEQUENCE CHARACTERISTICS:

(A) LENGTH: 317 amino acids

(B) TYPE: amino acid

(D) TOPOLOGY: linear

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:2:

```

Asp Cys Arg Ser Ser Ser Asn Asn Arg Xaa Pro Lys Gly Gly Ala Ala
1           5           10           15
Arg Ala Gly Gly Pro Ala Arg Pro Val Ser Leu Arg Glu Val Val Arg
20           25           30
Tyr Leu Gly Gly Ser Ser Gly Ala Gly Gly Arg Leu Thr Arg Gly Arg
35           40           45

```

Val Gln Gly Leu Leu Glu Glu Glu Ala Ala Ala Arg Gly Arg Leu Glu
 50 55 60
 Arg Thr Arg Leu Gly Ala Leu Ala Leu Pro Arg Gly Asp Arg Pro Gly
 65 70 75 80
 Arg Ala Pro Pro Ala Ala Ser Ala Arg Ala Ala Arg Asn Lys Arg Ala
 85 90 95
 Gly Glu Glu Arg Val Leu Glu Lys Glu Glu Glu Glu Glu Glu Glu
 100 105 110
 Asp Asp Glu Asp Asp Asp Asp Val Val Ser Glu Gly Ser Glu Val
 115 120 125
 Pro Glu Ser Asp Arg Pro Ala Gly Ala Gln His His Gln Leu Asn Gly
 130 135 140
 Gly Glu Arg Gly Pro Gln Thr Ala Lys Glu Arg Ala Lys Glu Trp Ser
 145 150 155 160
 Leu Cys Gly Pro His Pro Gly Gln Glu Glu Gly Arg Gly Pro Ala Ala
 165 170 175
 Gly Ser Gly Thr Arg Gln Val Phe Ser Met Ala Ala Leu Ser Lys Glu
 180 185 190
 Gly Gly Ser Ala Ser Ser Thr Thr Gly Pro Asp Ser Pro Ser Pro Val
 195 200 205
 Pro Leu Pro Pro Gly Lys Pro Ala Leu Pro Gly Ala Asp Gly Thr Pro
 210 215 220
 Phe Gly Cys Pro Ala Gly Arg Lys Glu Lys Pro Ala Asp Pro Val Glu
 225 230 235 240
 Trp Thr Val Met Asp Val Val Glu Tyr Phe Thr Glu Ala Gly Phe Pro
 245 250 255
 Glu Gln Ala Thr Ala Phe Gln Glu Gln Glu Ile Asp Gly Lys Ser Leu
 260 265 270
 Leu Leu Met Gln Arg Thr Asp Val Leu Thr Gly Leu Ser Ile Arg Leu
 275 280 285
 Gly Pro Ala Leu Lys Ile Tyr Glu His His Ile Lys Val Leu Gln Gln
 290 295 300
 Gly His Phe Glu Asp Asp Asp Pro Glu Gly Phe Leu Gly
 305 310 315

(2) INFORMATION FOR SEQ ID NO:3:

(i) SEQUENCE CHARACTERISTICS:

(A) LENGTH: 232 amino acids

(B) TYPE: amino acid

(D) TOPOLOGY: linear

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:3:

Ala	Ser	Ala	Arg	Ala	Ala	Arg	Asn	Lys	Arg	Ala	Gly	Glu	Glu	Arg	Val	1	5	10	15
Leu	Glu	Lys	Glu	Glu	Glu	Glu	Glu	Glu	Glu	Glu	Asp	Asp	Glu	Asp	Asp	20	25	30	
Asp	Asp	Asp	Val	Val	Ser	Glu	Gly	Ser	Glu	Val	Pro	Glu	Ser	Asp	Arg	35	40	45	
Pro	Ala	Gly	Ala	Gln	His	His	Gln	Leu	Asn	Gly	Gly	Glu	Arg	Gly	Pro	50	55	60	
Gln	Thr	Ala	Lys	Glu	Arg	Ala	Lys	Glu	Trp	Ser	Leu	Cys	Gly	Pro	His	65	70	75	80
Pro	Gly	Gln	Glu	Glu	Gly	Arg	Gly	Pro	Ala	Ala	Gly	Ser	Gly	Thr	Arg	85	90	95	
Gln	Val	Phe	Ser	Met	Ala	Ala	Leu	Ser	Lys	Glu	Gly	Gly	Ser	Ala	Ser	100	105	110	
Ser	Thr	Thr	Gly	Pro	Asp	Ser	Pro	Ser	Pro	Val	Pro	Leu	Pro	Pro	Gly	115	120	125	
Lys	Pro	Ala	Leu	Pro	Gly	Ala	Asp	Gly	Thr	Pro	Phe	Gly	Cys	Pro	Ala	130	135	140	
Gly	Arg	Lys	Glu	Lys	Pro	Ala	Asp	Pro	Val	Glu	Trp	Thr	Val	Met	Asp	145	150	155	160
Val	Val	Glu	Tyr	Phe	Thr	Glu	Ala	Gly	Phe	Pro	Glu	Gln	Ala	Thr	Ala	165	170	175	
Phe	Gln	Glu	Gln	Glu	Ile	Asp	Gly	Lys	Ser	Leu	Leu	Leu	Met	Gln	Arg	180	185	190	
Thr	Asp	Val	Leu	Thr	Gly	Leu	Ser	Ile	Arg	Leu	Gly	Pro	Ala	Leu	Lys	195	200	205	
Ile	Tyr	Glu	His	His	Ile	Lys	Val	Leu	Gln	Gln	Gly	His	Phe	Glu	Asp	210	215	220	
Asp	Asp	Pro	Glu	Gly	Phe	Leu	Gly									225	230		

(2) INFORMATION FOR SEQ ID NO:4:

(i) SEQUENCE CHARACTERISTICS:

(A) LENGTH: 252 amino acids

(B) TYPE: amino acid

(D) TOPOLOGY: linear

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:4:

```

Thr Arg Leu Gly Ala Leu Ala Leu Pro Arg Gly Asp Arg Pro Gly Arg
1           5           10           15

Ala Pro Pro Ala Ala Ser Ala Arg Ala Ala Arg Asn Lys Arg Ala Gly
20           25           30

Glu Glu Arg Val Leu Glu Lys Glu Glu Glu Glu Glu Glu Glu Glu Asp
35           40           45

Asp Glu Asp Asp Asp Asp Asp Val Val Ser Glu Gly Ser Glu Val Pro
50           55           60

Glu Ser Asp Arg Pro Ala Gly Ala Gln His His Gln Leu Asn Gly Gly
65           70           75           80

Glu Arg Gly Pro Gln Thr Ala Lys Glu Arg Ala Lys Glu Trp Ser Leu
85           90           95

Cys Gly Pro His Pro Gly Gln Glu Glu Gly Arg Gly Pro Ala Ala Gly
100          105          110

Ser Gly Thr Arg Gln Val Phe Ser Met Ala Ala Leu Ser Lys Glu Gly
115          120          125

Gly Ser Ala Ser Ser Thr Thr Gly Pro Asp Ser Pro Ser Pro Val Pro
130          135          140

Leu Pro Pro Gly Lys Pro Ala Leu Pro Gly Ala Asp Gly Thr Pro Phe
145          150          155          160

Gly Cys Pro Ala Gly Arg Lys Glu Lys Pro Ala Asp Pro Val Glu Trp
165          170          175

Thr Val Met Asp Val Val Glu Tyr Phe Thr Glu Ala Gly Phe Pro Glu
180          185          190

Gln Ala Thr Ala Phe Gln Glu Gln Glu Ile Asp Gly Lys Ser Leu Leu
195          200          205

Leu Met Gln Arg Thr Asp Val Leu Thr Gly Leu Ser Ile Arg Leu Gly
210          215          220

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Pro Ala Leu Lys Ile Tyr Glu His His Ile Lys Val Leu Gln Gln Gly
 225 230 235 240

His Phe Glu Asp Asp Asp Pro Glu Gly Phe Leu Gly
 245 250

(2) INFORMATION FOR SEQ ID NO:5:

(i) SEQUENCE CHARACTERISTICS:

(A) LENGTH: 557 amino acids

(B) TYPE: amino acid

(D) TOPOLOGY: linear

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:5:

Met Lys Asn Gln Asp Lys Lys Asn Gly Ala Ala Lys Gln Pro Asn Pro
 1 5 10 15

Lys Ser Ser Pro Gly Gln Pro Glu Ala Gly Ala Glu Gly Ala Gln Gly
 20 25 30

Arg Pro Gly Arg Pro Ala Pro Ala Arg Glu Ala Glu Gly Ala Ser Ser
 35 40 45

Gln Ala Pro Gly Arg Pro Glu Gly Ala Gln Ala Lys Thr Ala Gln Pro
 50 55 60

Gly Ala Leu Cys Asp Val Ser Glu Glu Leu Ser Arg Gln Leu Glu Asp
 65 70 75 80

Ile Leu Ser Thr Tyr Cys Val Asp Asn Asn Gln Gly Ala Pro Gly Glu
 85 90 95

Asp Gly Val Gln Gly Glu Pro Pro Glu Pro Glu Asp Ala Glu Lys Ser
 100 105 110

Arg Ala Tyr Val Ala Arg Asn Gly Glu Pro Glu Pro Gly Thr Pro Val
 115 120 125

Val Asn Gly Glu Lys Glu Thr Ser Lys Ala Glu Pro Gly Thr Glu Glu
 130 135 140

Ile Arg Thr Ser Asp Glu Val Gly Asp Arg Asp His Arg Arg Pro Gln
 145 150 155 160

Glu Lys Lys Lys Ala Lys Gly Leu Gly Lys Glu Ile Thr Leu Leu Met
 165 170 175

Gln Thr Leu Asn Thr Leu Ser Thr Pro Glu Glu Lys Leu Ala Ala Leu
 180 185 190

Cys Lys Lys Tyr Ala Glu Leu Leu Glu Glu His Arg Asn Ser Gln Lys
 195 200 205
 Gln Met Lys Leu Leu Gln Lys Lys Gln Ser Gln Leu Val Gln Glu Lys
 210 215 220
 Asp His Leu Arg Gly Glu His Ser Lys Ala Ile Leu Ala Arg Ser Lys
 225 230 235 240
 Leu Glu Ser Leu Cys Arg Glu Leu Gln Arg His Asn Arg Ser Leu Lys
 245 250 255
 Glu Glu Gly Val Gln Arg Ala Arg Glu Glu Glu Glu Lys Arg Lys Glu
 260 265 270
 Val Thr Ser His Phe Gln Met Thr Leu Asn Asp Ile Gln Leu Gln Met
 275 280 285
 Glu Gln His Asn Glu Arg Asn Ser Lys Leu Arg Gln Glu Asn Met Glu
 290 295 300
 Leu Ala Glu Arg Leu Lys Lys Leu Ile Glu Gln Tyr Glu Leu Arg Glu
 305 310 315 320
 Glu His Ile Asp Lys Val Phe Lys His Lys Asp Leu Gln Gln Gln Leu
 325 330 335
 Val Asp Ala Lys Leu Gln Gln Ala Gln Glu Met Leu Lys Glu Ala Glu
 340 345 350
 Glu Arg His Gln Arg Glu Lys Asp Phe Leu Leu Lys Glu Ala Val Glu
 355 360 365
 Ser Gln Arg Met Cys Glu Leu Met Lys Gln Gln Glu Thr His Leu Lys
 370 375 380
 Gln Gln Leu Ala Leu Tyr Thr Glu Lys Phe Glu Glu Phe Gln Asn Thr
 385 390 395 400
 Leu Ser Lys Ser Ser Glu Val Phe Thr Thr Phe Lys Gln Glu Met Glu
 405 410 415
 Lys Met Thr Lys Lys Ile Lys Lys Leu Glu Lys Glu Thr Thr Met Tyr
 420 425 430
 Arg Ser Arg Trp Glu Ser Ser Asn Lys Ala Leu Leu Glu Met Ala Glu
 435 440 445
 Glu Lys Thr Leu Arg Asp Lys Glu Leu Glu Gly Leu Gln Val Lys Ile
 450 455 460
 Gln Arg Leu Glu Lys Leu Cys Arg Ala Leu Gln Thr Glu Arg Asn Asp
 465 470 475 480

Leu Asn Lys Arg Val Gln Asp Leu Ser Ala Gly Gly Gln Gly Pro Val
 485 490 495
 Ser Asp Ser Gly Pro Glu Arg Arg Pro Glu Pro Ala Thr Thr Ser Lys
 500 505 510
 Glu Gln Gly Val Glu Gly Pro Gly Ala Gln Val Pro Asn Ser Pro Arg
 515 520 525
 Ala Thr Asp Ala Ser Cys Cys Ala Gly Ala Pro Ser Thr Glu Ala Ser
 530 535 540
 Gly Gln Thr Gly Pro Gln Glu Pro Thr Thr Ala Thr Ala
 545 550 555

(2) INFORMATION FOR SEQ ID NO:6:

(i) SEQUENCE CHARACTERISTICS:

(A) LENGTH: 151 amino acids

(B) TYPE: amino acid

(D) TOPOLOGY: linear

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:6:

Met Ser Lys Asn Thr Val Ser Ser Ala Arg Phe Arg Lys Val Asp Val
 1 5 10 15
 Asp Glu Tyr Asp Glu Asn Lys Phe Val Asp Glu Glu Asp Gly Gly Asp
 20 25 30
 Gly Gln Ala Gly Pro Asp Glu Gly Glu Val Asp Ser Cys Leu Arg Gln
 35 40 45
 Gly Asn Met Thr Ala Ala Leu Gln Ala Ala Leu Lys Asn Pro Pro Ile
 50 55 60
 Asn Thr Lys Ser Gln Ala Val Lys Asp Arg Ala Gly Ser Ile Val Leu
 65 70 75 80
 Lys Val Leu Ile Ser Phe Lys Ala Asn Asp Ile Glu Lys Ala Val Gln
 85 90 95
 Ser Leu Asp Lys Asn Gly Val Asp Leu Leu Met Lys Tyr Ile Tyr Lys
 100 105 110
 Gly Phe Glu Ser Pro Ser Asp Asn Ser Ser Ala Met Leu Leu Gln Trp
 115 120 125
 His Glu Lys Ala Leu Ala Ala Gly Gly Val Gly Ser Ile Val Arg Val
 130 135 140

Leu Thr Ala Arg Lys Thr Val
145 150

(2) INFORMATION FOR SEQ ID NO:7:

(i) SEQUENCE CHARACTERISTICS:

(A) LENGTH: 217 amino acids

(B) TYPE: amino acid

(D) TOPOLOGY: linear

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:7:

Glu Glu Arg Val Leu Glu Lys Glu Glu Glu Glu Asp Asp Asp Glu Asp
1 5 10 15
Glu Asp Glu Glu Asp Asp Val Ser Glu Gly Ser Glu Val Pro Glu Ser
20 25 30
Asp Arg Pro Ala Gly Ala Gln His His Gln Leu Asn Gly Glu Arg Gly
35 40 45
Pro Gln Ser Ala Lys Glu Arg Val Lys Glu Trp Thr Pro Cys Gly Pro
50 55 60
His Gln Gly Gln Asp Glu Gly Arg Gly Pro Ala Pro Gly Ser Gly Thr
65 70 75 80
Arg Gln Val Phe Ser Met Ala Ala Met Asn Lys Glu Gly Gly Thr Ala
85 90 95
Ser Val Ala Thr Gly Pro Asp Ser Pro Ser Pro Val Pro Leu Pro Pro
100 105 110
Gly Lys Pro Ala Leu Pro Gly Ala Asp Gly Thr Pro Phe Gly Cys Pro
115 120 125
Pro Gly Arg Lys Glu Lys Pro Ser Asp Pro Val Glu Trp Thr Val Met
130 135 140
Asp Val Val Glu Tyr Phe Thr Glu Ala Gly Phe Pro Glu Gln Ala Thr
145 150 155 160
Ala Phe Gln Glu Gln Glu Ile Asp Gly Lys Ser Leu Leu Leu Met Gln
165 170 175
Arg Thr Asp Val Leu Thr Gly Leu Ser Ile Arg Leu Gly Pro Ala Leu
180 185 190
Lys Ile Tyr Glu His His Ile Lys Val Leu Gln Gln Gly His Phe Glu
195 200 205

Asp Asp Asp Pro Asp Gly Phe Leu Gly
210 215

(2) INFORMATION FOR SEQ ID NO:8:

(i) SEQUENCE CHARACTERISTICS:

(A) LENGTH: 530 amino acids

(B) TYPE: amino acid

(D) TOPOLOGY: linear

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:8:

Lys Ser Ser Pro Gly Gln Pro Glu Ala Gly Pro Glu Gly Ala Gln Glu
1 5 10 15

Arg Pro Ser Gln Ala Ala Pro Ala Val Glu Ala Glu Gly Pro Gly Ser
20 25 30

Ser Gln Ala Pro Arg Lys Pro Glu Gly Ala Gln Ala Arg Thr Ala Gln
35 40 45

Ser Gly Ala Leu Arg Asp Val Ser Glu Glu Leu Ser Arg Gln Leu Glu
50 55 60

Asp Ile Leu Ser Thr Tyr Cys Val Asp Asn Asn Gln Gly Gly Pro Gly
65 70 75 80

Glu Asp Gly Ala Gln Gly Glu Pro Ala Glu Pro Glu Asp Ala Glu Lys
85 90 95

Ser Arg Thr Tyr Val Ala Arg Asn Gly Glu Pro Glu Pro Thr Pro Val
100 105 110

Val Tyr Gly Glu Lys Glu Pro Ser Lys Gly Asp Pro Asn Thr Glu Glu
115 120 125

Ile Arg Gln Ser Asp Glu Val Gly Asp Arg Asp His Arg Arg Pro Gln
130 135 140

Glu Lys Lys Lys Ala Lys Gly Leu Gly Lys Glu Ile Thr Leu Leu Met
145 150 155 160

Gln Thr Leu Asn Thr Leu Ser Thr Pro Glu Glu Lys Leu Ala Ala Leu
165 170 175

Cys Lys Lys Tyr Ala Glu Leu Leu Glu Glu His Arg Asn Ser Gln Lys
180 185 190

Gln Met Lys Leu Leu Gln Lys Lys Gln Ser Gln Leu Val Gln Glu Lys
195 200 205

Asp His Leu Arg Gly Glu His Ser Lys Ala Val Leu Ala Arg Ser Lys
 210 215 220
 Leu Glu Ser Leu Cys Arg Glu Leu Gln Arg His Asn Arg Ser Leu Lys
 225 230 235 240
 Glu Glu Gly Val Gln Arg Ala Arg Glu Glu Glu Glu Lys Arg Lys Glu
 245 250 255
 Val Thr Ser His Phe Gln Val Thr Leu Asn Asp Ile Gln Leu Gln Met
 260 265 270
 Glu Gln His Asn Glu Arg Asn Ser Lys Leu Arg Gln Glu Asn Met Glu
 275 280 285
 Leu Ala Glu Arg Leu Lys Lys Leu Ile Glu Gln Tyr Glu Leu Arg Glu
 290 295 300
 Glu His Ile Asp Lys Val Phe Lys His Lys Asp Leu Gln Gln Gln Leu
 305 310 315 320
 Val Asp Ala Lys Leu Gln Gln Ala Gln Glu Met Leu Lys Glu Ala Glu
 325 330 335
 Glu Arg His Gln Arg Glu Lys Asp Phe Leu Leu Lys Glu Ala Val Glu
 340 345 350
 Ser Gln Arg Met Cys Glu Leu Met Lys Gln Gln Glu Thr His Leu Lys
 355 360 365
 Gln Gln Leu Ala Leu Tyr Thr Glu Lys Phe Glu Glu Phe Gln Asn Thr
 370 375 380
 Leu Ser Lys Ser Ser Glu Val Phe Thr Thr Phe Lys Gln Glu Met Glu
 385 390 395 400
 Lys Met Thr Lys Lys Ile Lys Lys Leu Glu Lys Glu Thr Thr Met Tyr
 405 410 415
 Arg Ser Arg Trp Glu Ser Ser Asn Lys Ala Leu Leu Glu Met Ala Glu
 420 425 430
 Glu Lys Thr Val Arg Asp Lys Glu Leu Glu Gly Leu Gln Val Lys Ile
 435 440 445
 Gln Arg Leu Glu Lys Leu Cys Arg Ala Leu Gln Thr Glu Arg Asn Asp
 450 455 460
 Leu Asn Lys Arg Val Gln Asp Leu Ser Ala Gly Gly Gln Gly Ser Leu
 465 470 475 480
 Thr Asp Ser Gly Pro Glu Arg Arg Pro Glu Gly Pro Gly Ala Gln Ala
 485 490 495

Pro Ser Ser Pro Arg Val Thr Glu Ala Pro Cys Tyr Pro Gly Ala Pro
 500 505 510

Ser Thr Glu Ala Ser Gly Gln Thr Gly Pro Gln Glu Pro Thr Ser Ala
 515 520 525

Arg Ala
 530

(2) INFORMATION FOR SEQ ID NO:9:

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 20 amino acids
 (B) TYPE: amino acid
 (D) TOPOLOGY: linear

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:9:

Val Asp Val Asp Glu Tyr Asp Glu Asn Lys Phe Val Asp Glu Glu Asp
 1 5 10 15

Gly Gly Asp Gly
 20

(2) INFORMATION FOR SEQ ID NO:10:

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 1404 base pairs
 (B) TYPE: nucleic acid
 (C) STRANDEDNESS: single
 (D) TOPOLOGY: linear

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:10:

AAGCCTCGCA GCGGTCGGGG CGGCGCCGCG GAGGCTCGAG GGCGGCGGGC GGCGGCG 57

ATG TCG AAG AAC ACG GTG TCG TCG GCG CGG TTC CGG AAG GTG GAC GTG 105
 Met Ser Lys Asn Thr Val Ser Ser Ala Arg Phe Arg Lys Val Asp Val
 1 5 10 15

GAT GAG TAC GAC GAG AAC AAG TTC GTG GAC GAG GAA GAC GGC GGC GAC 153
 Asp Glu Tyr Asp Glu Asn Lys Phe Val Asp Glu Glu Asp Gly Gly Asp
 20 25 30

GGC CAG GCG GGG CCG GAC GAG GGC GAG GTG GAC TCG TGC CTG CGG CAA 201
 Gly Gln Ala Gly Pro Asp Glu Gly Glu Val Asp Ser Cys Leu Arg Gln
 35 40 45

GGG AAC ATG ACA GCC GCC CTG CAG GCG GCG CTG AAG AAC CCT CCC ATC 249
 Gly Asn Met Thr Ala Ala Leu Gln Ala Ala Leu Lys Asn Pro Pro Ile
 50 55 60

AAC ACC AGG AGC CAG GCG GTG AAG GAC CGG GCA GGC AGC ATC GTG CTG Asn Thr Arg Ser Gln Ala Val Lys Asp Arg Ala Gly Ser Ile Val Leu 65 70 75 80	297
AAG GTG CTC ATC TCC TTC AAG GCG GGC GAC ATA GAA AAG GCC GTG CAG Lys Val Leu Ile Ser Phe Lys Ala Gly Asp Ile Glu Lys Ala Val Gln 85 90 95	345
TCC CTG GAC AGG AAC GGC GTG GAC CTG CTC ATG AAG TAC ATC TAC AAG Ser Leu Asp Arg Asn Gly Val Asp Leu Leu Met Lys Tyr Ile Tyr Lys 100 105 110	393
GGC TTC GAG AGC CCC TCC GAC AAC AGC AGC GCC GTG CTC CTG CAG TGG Gly Phe Glu Ser Pro Ser Asp Asn Ser Ser Ala Val Leu Leu Gln Trp 115 120 125	441
CAC GAG AAG GCG CTG GCT GCA GGA GGA GTG GGC TCC ATC GTC CGT GTC His Glu Lys Ala Leu Ala Ala Gly Gly Val Gly Ser Ile Val Arg Val 130 135 140	489
CTG ACT GCA AGG AAA ACC GTG TAGCCTGGCA GGAACGGGTG CCTGCCGGGG Leu Thr Ala Arg Lys Thr Val 145 150	540
AGCGGGAGCT GCCGGTACAA AGACCAAAAC GCCCAGATGC CGCCGCTGCC CTGTGGGCGG	600
CGTCTGTTCC CAGCTTCGCT TTTTCCCTTT CCCGTGTCTG TCAGGATTAC ATAAGGTTTC	660
CCTTCGTGAG AATCGGAGTG GCGCAGAGGG TCCTGTTCAT ACGCGCCGTG CGTCCGGCTG	720
TGTAAGACCC CTGCCTTCAG TGTCTTGAG CAACGGTAGC GTGTCGCCGG CTGGGTTTGG	780
TTTTGTCTGTG GAGGGATCTG GTCAGAATTT GAGGCCAGTT TCCTAACTCA TTGCTGGTCA	840
GGAAATGATC TTCATTTAAA AAAAAAAAAA AGACTGGCAG CTATTATGCA AAAGTGGACC	900
CTCTTCCCTT ATTTAAGCAG AGTGAGTTTC TGGAACCACT GGTGCCCCC CCCCCGCCCC	960
GGCCGCCGTC CTGCTCAAGG GAAGCCTCCC TGCAGAGCAG CAGAGCCCCT GGGCAGGAGC	1020
GCCGCGTCCC GCTCCCAGGA GACAGCATGC GCGGTCACGC GGCACCTTCT GTGCCTCCCA	1080
GCCCCAGTGC CCCGGAGTTC TTCAGGGCGA CAGGGACCTC AGAAGACTGG ATCCGATCCA	1140
GACAGACGCC CATTCTTGGT TCAGCTCAGT GTTTTCAAAA GGAACGTGCT ACCGTGGGTA	1200
GAGCACACTG GTTCTCAGAA CACGGCCGGC GCTTGACGGT TGTCACAGCT CCAGAACAAA	1260
TCCTGGGAGA CAGGCGAGCG CGAGTCGCCG GGCAGGAATT CCACACACTC GTGCTGTTTT	1320
TGATACCTGC TTTTGTGTTTT GTTTTGTAAT AATGATGCAC TTGAGAAAAT AAAACGTCAG	1380
TGTTGACAAA AAAAAAAAAA AAAA	1404

(2) INFORMATION FOR SEQ ID NO:11:

(i) SEQUENCE CHARACTERISTICS:

(A) LENGTH: 1617 base pairs

(B) TYPE: nucleic acid
 (C) STRANDEDNESS: single
 (D) TOPOLOGY: linear

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:11:

GAC TGC CGC AGC AGC AGC AAC AAC CGC TAG CCG AAG GGT GGC GCG GCG	48
Asp Cys Arg Ser Ser Ser Asn Asn Arg Xaa Pro Lys Gly Gly Ala Ala	
1 5 10 15	
CGG GCC GGC GGC CCG GCG CGG CCC GTG AGC CTG CGG GAA GTC GTG CGC	96
Arg Ala Gly Gly Pro Ala Arg Pro Val Ser Leu Arg Glu Val Val Arg	
20 25 30	
TAC CTC GGG GGT AGC AGC GGC GCT GGC GGC CGC CTG ACC CGC GGC CGC	144
Tyr Leu Gly Gly Ser Ser Gly Ala Gly Gly Arg Leu Thr Arg Gly Arg	
35 40 45	
GTG CAG GGT CTG CTG GAA GAG GAG GCG GCG GCG CGG GGC CGC CTG GAG	192
Val Gln Gly Leu Leu Glu Glu Glu Ala Ala Ala Arg Gly Arg Leu Glu	
50 55 60	
CGC ACC CGT CTC GGA GCG CTT GCG CTG CCC CGC GGG GAC AGG CCC GGA	240
Arg Thr Arg Leu Gly Ala Leu Ala Leu Pro Arg Gly Asp Arg Pro Gly	
65 70 75 80	
CGG GCG CCA CCG GCC GCC AGC GCC CGC GCG GCG CGG AAC AAG AGA GCT	288
Arg Ala Pro Pro Ala Ala Ser Ala Arg Ala Ala Arg Asn Lys Arg Ala	
85 90 95	
GGC GAG GAG CGA GTG CTT GAA AAG GAG GAG GAG GAG GAG GAG GAG GAA	336
Gly Glu Glu Arg Val Leu Glu Lys Glu Glu Glu Glu Glu Glu Glu Glu	
100 105 110	
GAC GAC GAG GAC GAC GAC GAC GAC GTC GTG TCC GAG GGC TCG GAG GTG	384
Asp Asp Glu Asp Asp Asp Asp Asp Val Val Ser Glu Gly Ser Glu Val	
115 120 125	
CCC GAG AGC GAT CGT CCC GCG GGT GCG CAG CAT CAC CAG CTG AAT GGC	432
Pro Glu Ser Asp Arg Pro Ala Gly Ala Gln His His Gln Leu Asn Gly	
130 135 140	
GGC GAG CGC GGC CCG CAG ACC GCC AAG GAG CGG GCC AAG GAG TGG TCG	480
Gly Glu Arg Gly Pro Gln Thr Ala Lys Glu Arg Ala Lys Glu Trp Ser	
145 150 155 160	
CTG TGT GGC CCC CAC CCT GGC CAG GAG GAA GGG CGG GGG CCG GCC GCG	528
Leu Cys Gly Pro His Pro Gly Gln Glu Glu Gly Arg Gly Pro Ala Ala	
165 170 175	
GGC AGT GGC ACC CGC CAG GTG TTC TCC ATG GCG GCC TTG AGT AAG GAG	576
Gly Ser Gly Thr Arg Gln Val Phe Ser Met Ala Ala Leu Ser Lys Glu	
180 185 190	
GGG GGA TCA GCC TCT TCG ACC ACC GGG CCT GAC TCC CCG TCC CCG GTG	624
Gly Gly Ser Ala Ser Ser Thr Thr Gly Pro Asp Ser Pro Ser Pro Val	
195 200 205	

CCT TTG CCC CCC GGG AAG CCA GCC CTC CCA GGA GCC GAT GGG ACC CCC Pro Leu Pro Pro Gly Lys Pro Ala Leu Pro Gly Ala Asp Gly Thr Pro 210 215 220	672
TTT GGC TGC CCT GCC GGG CGC AAA GAG AAG CCG GCA GAC CCC GTG GAG Phe Gly Cys Pro Ala Gly Arg Lys Glu Lys Pro Ala Asp Pro Val Glu 225 230 235 240	720
TGG ACA GTC ATG GAC GTC GTG GAG TAC TTC ACC GAG GCG GGC TTC CCT Trp Thr Val Met Asp Val Val Glu Tyr Phe Thr Glu Ala Gly Phe Pro 245 250 255	768
GAG CAA GCC ACG GCT TTC CAG GAG CAG GAG ATC GAC GGC AAG TCC CTG Glu Gln Ala Thr Ala Phe Gln Glu Gln Glu Ile Asp Gly Lys Ser Leu 260 265 270	816
CTG CTC ATG CAG CGC ACC GAT GTC CTC ACC GGC CTG TCC ATC CGC CTG Leu Leu Met Gln Arg Thr Asp Val Leu Thr Gly Leu Ser Ile Arg Leu 275 280 285	864
GGG CCA GCG TTG AAA ATC TAT GAG CAC CAT ATC AAG GTG CTG CAG CAG Gly Pro Ala Leu Lys Ile Tyr Glu His His Ile Lys Val Leu Gln Gln 290 295 300	912
GGT CAC TTC GAG GAC GAT GAC CCG GAA GGC TTC CTG GGA TGAGCACAGA Gly His Phe Glu Asp Asp Asp Pro Glu Gly Phe Leu Gly 305 310 315	961
GGCGCCGCGC CCCTTGTCCT CACCCCCACC CCGCCTGGAC CCATTCCTGC CTCCATGTCA	1021
CCCAAGGTGT CCCAGAGGCC AGGAGCTGGA CTGGGCAGGC GAGGGGTGCG GACCTACCCT	1081
GATTCTGGTA GGGGGCGGGG CCTTGCTGTG CTCATTGCTA CCCCCCACC CCGTGTGTGT	1141
CTCTGCACCT GCCCCAGCA CACCCTCCC GGAGCCTGGA TGTCGCCTGG GACTCTGGCC	1201
TGCTCATTTT GCCCCAGAT CAGCCCCCTC CCTCCCTCCT GTCCCAGGAC ATTTTTTAAA	1261
AGAAAAAAG GAAAAAATAA AATTGGGGAG GGGGCTGGGA AGGTGCCCA AGATCCTCCT	1321
CGGCCCAACC AGGTGTTTAT TCCTATATAT ATATATATAT GTTTTGTCT GCCTGTTTTT	1381
CGTTTTTTGG TGCGTGGCCT TTCTTCCCTC CCACCACCAC TCATGGCCCC AGCCCTGCTC	1441
GCCCTGTGCG CGGGAGCAGC TGGGAATGGG AGGAGGTGG GACCTGGGT CTGTCTCCCA	1501
CCCTCTCTCC CGTTGGTTCT GTTGTGCTC CAGCTGGCTG TATTGCTTTT TAATATTGCA	1561
CCGAAGGGTT GTTTTTTTTT TTTTAAATAA AATTTTAAAA AAAGGAAAAA AAAAAA	1617

(2) INFORMATION FOR SEQ ID NO:12:

(i) SEQUENCE CHARACTERISTICS:

(A) LENGTH: 1362 bases

(B) TYPE: nucleic acid

(C) STRANDEDNESS: single

(D) TOPOLOGY: linear

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:12:

GCC AGC GCC CGC GCG GCG CGG AAC AAG AGA GCT GGC GAG GAG CGA GTG	48
Ala Ser Ala Arg Ala Ala Arg Asn Lys Arg Ala Gly Glu Glu Arg Val	
1 5 10 15	
CTT GAA AAG GAG GAG GAG GAG GAG GAG GAG GAA GAC GAC GAG GAC GAC	96
Leu Glu Lys Glu Glu Glu Glu Glu Glu Glu Glu Asp Asp Glu Asp Asp	
20 25 30	
GAC GAC GAC GTC GTG TCC GAG GGC TCG GAG GTG CCC GAG AGC GAT CGT	144
Asp Asp Asp Val Val Ser Glu Gly Ser Glu Val Pro Glu Ser Asp Arg	
35 40 45	
CCC GCG GGT GCG CAG CAT CAC CAG CTG AAT GGC GGC GAG CGC GGC CCG	192
Pro Ala Gly Ala Gln His His Gln Leu Asn Gly Gly Glu Arg Gly Pro	
50 55 60	
CAG ACC GCC AAG GAG CGG GCC AAG GAG TGG TCG CTG TGT GGC CCC CAC	240
Gln Thr Ala Lys Glu Arg Ala Lys Glu Trp Ser Leu Cys Gly Pro His	
65 70 75 80	
CCT GGC CAG GAG GAA GGG CGG GGG CCG GCC GCG GGC AGT GGC ACC CGC	288
Pro Gly Gln Glu Glu Gly Arg Gly Pro Ala Ala Gly Ser Gly Thr Arg	
85 90 95	
CAG GTG TTC TCC ATG GCG GCC TTG AGT AAG GAG GGG GGA TCA GCC TCT	336
Gln Val Phe Ser Met Ala Ala Leu Ser Lys Glu Gly Gly Ser Ala Ser	
100 105 110	
TCG ACC ACC GGG CCT GAC TCC CCG TCC CCG GTG CCT TTG CCC CCC GGG	384
Ser Thr Thr Gly Pro Asp Ser Pro Ser Pro Val Pro Leu Pro Pro Gly	
115 120 125	
AAG CCA GCC CTC CCA GGA GCC GAT GGG ACC CCC TTT GGC TGC CCT GCC	432
Lys Pro Ala Leu Pro Gly Ala Asp Gly Thr Pro Phe Gly Cys Pro Ala	
130 135 140	
GGG CGC AAA GAG AAG CCG GCA GAC CCC GTG GAG TGG ACA GTC ATG GAC	480
Gly Arg Lys Glu Lys Pro Ala Asp Pro Val Glu Trp Thr Val Met Asp	
145 150 155 160	
GTC GTG GAG TAC TTC ACC GAG GCG GGC TTC CCT GAG CAA GCC ACG GCT	528
Val Val Glu Tyr Phe Thr Glu Ala Gly Phe Pro Glu Gln Ala Thr Ala	
165 170 175	
TTC CAG GAG CAG GAG ATC GAC GGC AAG TCC CTG CTG CTC ATG CAG CGC	576
Phe Gln Glu Gln Glu Ile Asp Gly Lys Ser Leu Leu Leu Met Gln Arg	
180 185 190	
ACC GAT GTC CTC ACC GGC CTG TCC ATC CGC CTG GGG CCA GCG TTG AAA	624
Thr Asp Val Leu Thr Gly Leu Ser Ile Arg Leu Gly Pro Ala Leu Lys	
195 200 205	

ATC TAT GAG CAC CAT ATC AAG GTG CTG CAG CAG GGT CAC TTC GAG GAC 672
 Ile Tyr Glu His His Ile Lys Val Leu Gln Gln Gly His Phe Glu Asp
 210 215 220

GAT GAC CCG GAA GGC TTC CTG GGA TGAGCACAGA GCCGCCCGC CCCTTGTCCTC 726
 Asp Asp Pro Glu Gly Phe Leu Gly
 225 230

CACCCCCACC CCGCCTGGAC CCATTCCTGC CTCCATGTCA CCCAAGGTGT CCCAGAGGCC 786

AGGAGCTGGA CTGGGCAGGC GAGGGGTGCG GACCTACCCT GATTCTGGTA GGGGGCGGGG 846

CCTTGCTGTG CTCATTGCTA CCCCCCACC CCGTGTGTGT CTCTGCACCT GCCCCCAGCA 906

CACCCCTCCC GGAGCCTGGA TGTCGCCTGG GACTCTGGCC TGCTCATTTT GCCCCCAGAT 966

CAGCCCCCTC CCTCCCTCCT GTCCCAGGAC ATTTTTTAAA AGAAAAAAG GAAAAAATAA 1026

AATTGGGGAG GGGGCTGGGA AGGTGCCCCA AGATCCTCCT CGGCCCAACC AGGTGTTTAT 1086

TCCTATATAT ATATATATAT GTTTTGTCT GCCTGTTTTT CGTTTTTTGG TGCGTGGCCT 1146

TTCTTCCCTC CCACCACCAC TCATGGCCCC AGCCCTGCTC GCCCTGTCGG CGGGAGCAGC 1206

TGGGAATGGG AGGAGGGTGG GACCTTGGGT CTGTCTCCCA CCCTCTCTCC CGTTGGTTCT 1266

GTTGTCGCTC CAGCTGGCTG TATTGCTTTT TAATATTGCA CCGAAGGGTT GTTTTTTTTT 1326

TTTTAAATAA AATTTTAAAA AAAGGAAAAA AAAAAA 1362

(2) INFORMATION FOR SEQ ID NO:13:

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 1422 bases
- (B) TYPE: nucleic acid
- (C) STRANDEDNESS: single
- (D) TOPOLOGY: linear

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:13:

ACC CGT CTC GGA GCG CTT GCG CTG CCC CGC GGG GAC AGG CCC GGA CGG 48
 Thr Arg Leu Gly Ala Leu Ala Leu Pro Arg Gly Asp Arg Pro Gly Arg
 1 5 10 15

GCG CCA CCG GCC GCC AGC GCC CGC GCG GCG CGG AAC AAG AGA GCT GGC 96
 Ala Pro Pro Ala Ala Ser Ala Arg Ala Ala Arg Asn Lys Arg Ala Gly
 20 25 30

GAG GAG CGA GTG CTT GAA AAG GAG GAG GAG GAG GAG GAG GAG GAA GAC 144
 Glu Glu Arg Val Leu Glu Lys Glu Glu Glu Glu Glu Glu Glu Glu Asp
 35 40 45

GAC GAG GAC GAC GAC GAC GAC GTC GTG TCC GAG GGC TCG GAG GTG CCC 192
 Asp Glu Asp Asp Asp Asp Asp Val Val Ser Glu Gly Ser Glu Val Pro
 50 55 60

GAG AGC GAT CGT CCC GCG GGT GCG CAG CAT CAC CAG CTG AAT GGC GGC 240
 Glu Ser Asp Arg Pro Ala Gly Ala Gln His His Gln Leu Asn Gly Gly
 65 70 75 80

GAG CGC GGC CCG CAG ACC GCC AAG GAG CGG GCC AAG GAG TGG TCG CTG 288
 Glu Arg Gly Pro Gln Thr Ala Lys Glu Arg Ala Lys Glu Trp Ser Leu
 85 90 95

TGT GGC CCC CAC CCT GGC CAG GAG GAA GGG CGG GGG CCG GCC GCG GGC 336
 Cys Gly Pro His Pro Gly Gln Glu Glu Gly Arg Gly Pro Ala Ala Gly
 100 105 110

AGT GGC ACC CGC CAG GTG TTC TCC ATG GCG GCC TTG AGT AAG GAG GGC 384
 Ser Gly Thr Arg Gln Val Phe Ser Met Ala Ala Leu Ser Lys Glu Gly
 115 120 125

GGA TCA GCC TCT TCG ACC ACC GGG CCT GAC TCC CCG TCC CCG GTG CCT 432
 Gly Ser Ala Ser Ser Thr Thr Gly Pro Asp Ser Pro Ser Pro Val Pro
 130 135 140

TTG CCC CCC GGG AAG CCA GCC CTC CCA GGA GCC GAT GGG ACC CCC TTT 480
 Leu Pro Pro Gly Lys Pro Ala Leu Pro Gly Ala Asp Gly Thr Pro Phe
 145 150 155 160

GGC TGC CCT GCC GGG CGC AAA GAG AAG CCG GCA GAC CCC GTG GAG TGG 528
 Gly Cys Pro Ala Gly Arg Lys Glu Lys Pro Ala Asp Pro Val Glu Trp
 165 170 175

ACA GTC ATG GAC GTC GTG GAG TAC TTC ACC GAG GCG GGC TTC CCT GAG 576
 Thr Val Met Asp Val Val Glu Tyr Phe Thr Glu Ala Gly Phe Pro Glu
 180 185 190

CAA GCC ACG GCT TTC CAG GAG CAG GAG ATC GAC GGC AAG TCC CTG CTG 624
 Gln Ala Thr Ala Phe Gln Glu Gln Glu Ile Asp Gly Lys Ser Leu Leu
 195 200 205

CTC ATG CAG CGC ACC GAT GTC CTC ACC GGC CTG TCC ATC CGC CTG GGC 672
 Leu Met Gln Arg Thr Asp Val Leu Thr Gly Leu Ser Ile Arg Leu Gly
 210 215 220

CCA GCG TTG AAA ATC TAT GAG CAC CAT ATC AAG GTG CTG CAG CAG GGT 720
 Pro Ala Leu Lys Ile Tyr Glu His His Ile Lys Val Leu Gln Gln Gly
 225 230 235 240

CAC TTC GAG GAC GAT GAC CCG GAA GGC TTC CTG GGA TGAGCACAGA 766
 His Phe Glu Asp Asp Asp Pro Glu Gly Phe Leu Gly
 245 250

GCCGCCGCGC CCCTTGTCCT CACCCCCACC CCGCCTGGAC CCATTCCTGC CTCCATGTCA 826

CCCAAGGTGT CCCAGAGGCC AGGAGCTGGA CTGGGCAGGC GAGGGGTGCG GACCTACCCT 886

GATTCTGGTA GGGGGCGGGG CCTTGCTGTG CTCATTGCTA CCCCCCACC CCGTGTGTGT 946

CTCTGCACCT GCCCCAGCA CACCCTCCC GGAGCCTGGA TGTCGCCTGG GACTCTGGCC 1006

TGCTCATTTT GCCCCAGAT CAGCCCCCTC CCTCCCTCCT GTCCAGGAC ATTTTTTAA 1066

AGAAAAAAG GAAAAAATAA AATTGGGGAG GGGGCTGGGA AGGTGCCCCA AGATCCTCCT 1126
 CGGCCCCAACC AGGTGTTTAT TCCTATATAT ATATATATAT GTTTTGTCTT GCCTGTTTTT 1186
 CGTTTTTTTGG TCGGTGGCCT TTCTTCCCTC CCACCACCAC TCATGGCCCC AGCCCTGCTC 1246
 GCCCTGTTCGG CGGGAGCAGC TGGGAATGGG AGGAGGGTGG GACCTTGGGT CTGTCTCCCA 1306
 CCCTCTCTCC CGTTGGTTCT GTTGTCGCTC CAGCTGGCTG TATTGCTTTT TAATATTGCA 1366
 CCGAAGGGTT GTTTTTTTTT TTTTAAATAA AATTTTAAAA AAAGGAAAAA AAAAAA 1422

(2) INFORMATION FOR SEQ ID NO:14:

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 4722 base pairs
- (B) TYPE: nucleic acid
- (C) STRANDEDNESS: single
- (D) TOPOLOGY: linear

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:14:

GTGGAAAATA GCAACTGTGT TTCTCAAGGA TCCAATCCCA ACCTAAGGTG GCAGCGCACA 60
 ATG AAG AAT CAA GAC AAA AAG AAC GGG GCT GCC AAA CAG CCC AAC CCC 108
 Met Lys Asn Gln Asp Lys Lys Asn Gly Ala Ala Lys Gln Pro Asn Pro
 1 5 10 15
 AAA AGC AGC CCG GGA CAG CCG GAA GCA GGA GCG GAG GGA GCC CAG GGG 156
 Lys Ser Ser Pro Gly Gln Pro Glu Ala Gly Ala Glu Gly Ala Gln Gly
 20 25 30
 CGG CCC GGC CGG CCG GCC CCC GCC CGA GAA GCC GAA GGT GCC AGC AGC 204
 Arg Pro Gly Arg Pro Ala Pro Ala Arg Glu Ala Glu Gly Ala Ser Ser
 35 40 45
 CAG GCT CCC GGG AGG CCG GAG GGG GCT CAA GCC AAA ACT GCT CAG CCT 252
 Gln Ala Pro Gly Arg Pro Glu Gly Ala Gln Ala Lys Thr Ala Gln Pro
 50 55 60
 GGG GCG CTC TGT GAT GTC TCT GAG GAG CTG AGC CGC CAG TTG GAA GAC 300
 Gly Ala Leu Cys Asp Val Ser Glu Glu Leu Ser Arg Gln Leu Glu Asp
 65 70 75 80
 ATA CTC AGT ACA TAC TGT GTG GAC AAC AAC CAG GGG GCC CCG GGT GAG 348
 Ile Leu Ser Thr Tyr Cys Val Asp Asn Asn Gln Gly Ala Pro Gly Glu
 85 90 95
 GAT GGG GTC CAG GGT GAG CCC CCT GAA CCT GAA GAT GCA GAG AAG TCT 396
 Asp Gly Val Gln Gly Glu Pro Pro Glu Pro Glu Asp Ala Glu Lys Ser
 100 105 110
 CGC GCC TAT GTG GCA AGG AAT GGG GAG CCG GAG CCG GGC ACC CCA GTA 444
 Arg Ala Tyr Val Ala Arg Asn Gly Glu Pro Glu Pro Gly Thr Pro Val
 115 120 125

GTC AAT GGC GAG AAG GAG ACC TCC AAG GCA GAG CCG GGC ACG GAA GAG Val Asn Gly Glu Lys Glu Thr Ser Lys Ala Glu Pro Gly Thr Glu Glu 130 135 140	492
ATC CGG ACG AGC GAT GAG GTC GGA GAC CGA GAC CAC CGG AGG CCA CAG Ile Arg Thr Ser Asp Glu Val Gly Asp Arg Asp His Arg Arg Pro Gln 145 150 155 160	540
GAA AAG AAG AAG GCC AAG GGT CTG GGA AAG GAG ATC ACG CTG CTG ATG Glu Lys Lys Lys Ala Lys Gly Leu Gly Lys Glu Ile Thr Leu Leu Met 165 170 175	588
CAG ACA CTG AAC ACG CTG AGC ACC CCA GAG GAG AAG CTG GCG GCT CTG Gln Thr Leu Asn Thr Leu Ser Thr Pro Glu Glu Lys Leu Ala Ala Leu 180 185 190	636
TGC AAG AAG TAT GCG GAA CTG CTC GAG GAG CAC CGG AAC TCG CAG AAG Cys Lys Lys Tyr Ala Glu Leu Leu Glu Glu His Arg Asn Ser Gln Lys 195 200 205	684
CAG ATG AAG CTG CTG CAG AAG AAG CAG AGC CAG CTG GTG CAG GAG AAG Gln Met Lys Leu Leu Gln Lys Lys Gln Ser Gln Leu Val Gln Glu Lys 210 215 220	732
GAC CAC CTG CGT GGC GAG CAC AGC AAG GCC ATC CTG GCC CGC AGC AAG Asp His Leu Arg Gly Glu His Ser Lys Ala Ile Leu Ala Arg Ser Lys 225 230 235 240	780
CTC GAG AGC CTG TGC CGG GAG CTG CAG CGG CAC AAC CGC TCG CTC AAG Leu Glu Ser Leu Cys Arg Glu Leu Gln Arg His Asn Arg Ser Leu Lys 245 250 255	828
GAA GAA GGT GTG CAG CGA GCC CGA GAG GAG GAG GAG AAG CGC AAG GAG Glu Glu Gly Val Gln Arg Ala Arg Glu Glu Glu Glu Lys Arg Lys Glu 260 265 270	876
GTG ACG TCA CAC TTC CAG ATG ACG CTC AAC GAC ATT CAG CTG CAG ATG Val Thr Ser His Phe Gln Met Thr Leu Asn Asp Ile Gln Leu Gln Met 275 280 285	924
GAG CAG CAC AAC GAG CGC AAC TCC AAG CTG CGC CAG GAG AAC ATG GAG Glu Gln His Asn Glu Arg Asn Ser Lys Leu Arg Gln Glu Asn Met Glu 290 295 300	972
CTG GCC GAG CGG CTC AAG AAG CTG ATT GAG CAG TAC GAG CTG CGA GAA Leu Ala Glu Arg Leu Lys Lys Leu Ile Glu Gln Tyr Glu Leu Arg Glu 305 310 315 320	1020
GAG CAC ATC GAC AAA GTC TTC AAA CAC AAG GAT CTG CAG CAG CAG CTG Glu His Ile Asp Lys Val Phe Lys His Lys Asp Leu Gln Gln Gln Leu 325 330 335	1068
GTG GAC GCC AAG CTC CAG CAG GCC CAG GAG ATG CTG AAG GAG GCA GAG Val Asp Ala Lys Leu Gln Gln Ala Gln Glu Met Leu Lys Glu Ala Glu 340 345 350	1116

GAG CGG CAC CAG CGG GAG AAG GAC TTT CTC CTG AAG GAG GCC GTG GAG Glu Arg His Gln Arg Glu Lys Asp Phe Leu Leu Lys Glu Ala Val Glu 355 360 365	1164
TCC CAG AGG ATG TGC GAG CTG ATG AAG CAA CAG GAG ACC CAC CTG AAG Ser Gln Arg Met Cys Glu Leu Met Lys Gln Gln Glu Thr His Leu Lys 370 375 380	1212
CAG CAG CTT GCC CTA TAC ACA GAG AAG TTT GAG GAG TTC CAG AAC ACT Gln Gln Leu Ala Leu Tyr Thr Glu Lys Phe Glu Glu Phe Gln Asn Thr 385 390 395 400	1260
CTT TCC AAA AGC AGC GAG GTG TTC ACC ACA TTC AAA CAG GAA ATG GAA Leu Ser Lys Ser Ser Glu Val Phe Thr Thr Phe Lys Gln Glu Met Glu 405 410 415	1308
AAG ATG ACA AAG AAG ATC AAG AAG CTG GAG AAA GAG ACC ACC ATG TAC Lys Met Thr Lys Lys Ile Lys Lys Leu Glu Lys Glu Thr Thr Met Tyr 420 425 430	1356
CGT TCC CGG TGG GAG AGC AGC AAC AAG GCC CTG CTT GAG ATG GCT GAG Arg Ser Arg Trp Glu Ser Ser Asn Lys Ala Leu Leu Glu Met Ala Glu 435 440 445	1404
GAG AAA ACA CTC CGG GAC AAA GAG CTG GAA GGC CTG CAG GTG AAA ATC Glu Lys Thr Leu Arg Asp Lys Glu Leu Glu Gly Leu Gln Val Lys Ile 450 455 460	1452
CAG CGG CTG GAG AAG CTG TGC CGG GCA CTG CAG ACA GAG CGC AAT GAC Gln Arg Leu Glu Lys Leu Cys Arg Ala Leu Gln Thr Glu Arg Asn Asp 465 470 475 480	1500
CTG AAC AAG AGG GTG CAG GAC CTG AGT GCC GGT GGC CAG GGC CCC GTC Leu Asn Lys Arg Val Gln Asp Leu Ser Ala Gly Gly Gln Gly Pro Val 485 490 495	1548
TCC GAC AGC GGT CCT GAG CGG AGG CCA GAG CCC GCC ACC ACC TCC AAG Ser Asp Ser Gly Pro Glu Arg Arg Pro Glu Pro Ala Thr Thr Ser Lys 500 505 510	1596
GAG CAG GGT GTC GAG GGC CCC GGG GCT CAA GTA CCC AAC TCT CCA AGG Glu Gln Gly Val Glu Gly Pro Gly Ala Gln Val Pro Asn Ser Pro Arg 515 520 525	1644
GCC ACA GAC GCT TCC TGC TGC GCA GGT GCA CCC AGC ACA GAG GCA TCA Ala Thr Asp Ala Ser Cys Cys Ala Gly Ala Pro Ser Thr Glu Ala Ser 530 535 540	1692
GGC CAG ACA GGG CCC CAG GAG CCC ACC ACT GCC ACT GCC TAGAGAGCTT Gly Gln Thr Gly Pro Gln Glu Pro Thr Thr Ala Thr Ala 545 550 555	1741
GGTGCTGGGG TGTGCCAGGA AGGGAGCAGG CAGCCCAGCC AGGCCTGGCC CAGCCCAGGC	1801
TCCCATGCTA AGCAGTCCGG TGCTGAGGCC AGGATGTTCT GACCTGGCTG GCACCTGACC	1861
CTCTGCAGTC TTGGATTTTG TGGGTCAGTT TTACATGCAT ATGGCACACA TGCAAGGCCT	1921

CACACATTTG TGTCTCTAAG TGTACTGTGG GCTTGCATCG GGGGTGACGA TGGACAGATG 1981
AAGCCAGCGG CTCCCTTGTG AGCTGAAGTC TTACGGAGGA GACGGCGTCT GCACTGCCAT 2041
CGCAGTGACC TGCAGGACGA GTTCCTTGAG CTTTCCCTGC CTGCTTTGAG GCTGAGACCC 2101
CTCCCGGCCC TTCAGAGCTC CTGACAGGTG ATACACACCC AGCCTTGACC GCACTTCTCT 2161
TGGGTAGCTG GGCTCTCCTA GCCTCCCCCA GAGGCGCCAT TGCTTCTCTT GACTTGGAGA 2221
GGGGATGCCC AGGCGTGGCC TTGGCAGGCA CTGGGAGCTA GTGATTGGGC TGCTCTCCTG 2281
CCTCGAGCAG GGGCAGGAGT GTTTCTGGTG GGATGATGCG CTCGCTGGTC AGGAGCCCCG 2341
TGGGCGCTGC TTCCCCCGCC CTCTGGTGAT GCCAGGACCA GGCCAGTGAT GCTTCTCAGT 2401
AGCCTTACCA TTCACAGGTG CCTCTCCAGC CCGCACAGTG AGTGACAAGA TCATCCAAAG 2461
GATTCCTTCT GAAGGTGTTT GTTTCGTTTT GTTTTGTGTC ACGTGACGGT TTGTATTGAG 2521
GACCCTCTGA GGAAGAGGGG TGCTGTAGCA GTGGTCCCTG CGTGCCTGGC TCCAGTGTCC 2581
TGCCCTCCCC CCCCTCGCCA TGGCTCCTCG GCCGCCTTGG TGCTGAGGTT TCTGTTTGGT 2641
GAGATCAGGT TGTCTGTTCA GAGAGAAGAG GCGTCTGATG GCTTTGCCGC CAGCTTGCCT 2701
GCGGGCCTCA ATCCCGGGAG GCCGCCCCGT TCCCGTCACT GTTGTCCCCG TGCAGTGCGT 2761
TGCTGGTCCC CAGGACCAGC TGCTCGTTTG CTGTATGGGT CAGTTTCTGC TTCCTGCCCC 2821
CCACTCCACC TAACTGCAAT CCTTGGGGTT TCCCTGGTTC TCGTCCCTGG TACCTCTGTG 2881
CCCAAGAAGT AGCCTTCTTT GGGATTCTTG TTCTGCCCAT GCGGGAGCTG CTGCTGTCTG 2941
ACAGGTGAGG CCTGAGACTC AGCGGCTGAC AGAGCTGCAG AGCTCTGCAC GGTGGCTCCC 3001
GGGGCGGCCT CTGTGTGCTG CACACCGCTG CTCTGCTGGC ACTGGCCAGT CTGTGCAGAG 3061
CATTTGAGTA CTGGCTCAGG AGGGAGGGCT CTGCTGGCCT CGAGGGACAG CGCCACGTCT 3121
CCAGCTGGGC TCAGGGAGAG CCCAGACTG GCTGCGTAGG GTGCTTGGGG TTTGCTTCTT 3181
GCAGTATTTT TTGGAAGCTG TTTTGTGTGTC CTGCTATTCC TTCATCTTCC ACAGTCCACG 3241
CTCAGCCTTT AACTTGATC CCTCACATAA CAGGGTTCAT GAGACCCGCA AGTACGCCCA 3301
AGCTACGTAT GGCTGAGGCC AGCTGGCAGG TGAATGGCAC GCCATTGCTG CTGCTAATCC 3361
CTGGCATATC TTTAGTTCAC CTCGAAATGC CCCC GCCACA GTGCAAGCAG TGAGTCCACG 3421
TGCCACCCTG GGCTGAATCC CACCCCTGT GAGTGTGTC CGAGATTGTG TCTCTTCTGA 3481
ATGCCTTCAC TGGGAATGGC CTCTGCCGCC TCCTGCTCAG GGAGGCTTTC CCCTTCCCTC 3541
AGCCCCTGTG CCAGACTGAG GTACAAGAAC CGCCAAGCCC ATGCAAGGTG TGGCTAGGCG 3601
CCAGGGTGCA GGAAGGAGGC AGGTAGCTGC CTGCACCCTT GAAAGCCAAG AGGCCTACGG 3661

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TGGCCTCCAT CCTGGCTTGC CTCACTTCAG CTACCTCGCA TAGCCCAGGG GTGGGGCTAT      3721
TGGATTCCAG GGTGGGGGGA TGGGAAGCTG CAGGGGGCAG GTGGCTCTCA CTAGGCTTCC      3781
CAGCTCAGGA ATGTGGGCCT CAGGTAGGGG AGAGCCTTTG CTCCACTCCA CCCATTTGCA      3841
GGCATCTAGG CCAGTCTAGA TGGCGACCCC TTCTCTTCCT CTCCATTGAC CAAATCGTAC      3901
CTGTCTCTCC AGCTGCTCGC TTGCTCTGCT TTCCAAAGTC AGCCCAGGTA CCCAGGTGCC      3961
GCCCCACATTG GCCTGGAACC TGGACCAGAG GCAAGGGAGG TGGCCTATCC TTGAGTGATA      4021
GCCAGTGCCT TCCTCACCCG GTGGCTTCCA TGCCTGTGAC CTCAGATTTA GGACCAAGAG      4081
CTGTGTTGGT TTCTTACGTT GTGAGCTTTC CCTCCAGGGG ACCACAGCAG GTGAGGCTCG      4141
GAGCCCAGAG CCCTTGGCGC CGCCAGCAGT AACTTGTGTC CGGACCTTGT CCAGCTGAGC      4201
GCTTCGTGTA TGA CTCAGCT TCGTGTGTGA GTCCAGCGGA GTGCGTCACG TGACCTAGAC      4261
TCAGCGGTGT CAGCCGCACT TTGATTTGTT TGTTTTCCAT GAGGTTTTTTG GACCATGGGC      4321
TTAGCTCAGG CAACTTTTCT GTAAGGAGAA TGTTAACTTT CTGTAAAGAT GCTTATTTAA      4381
CTAACGCCTG CTTCCCCCAC TCCCAACCAG GTGGCCACCG AGAGCTCACC AGGAGGCCAA      4441
TAGAGCTGCT CCAGCTCTCC CATCTTGAC CGCACAAAGG TGGCCGCCCC AGGGACAGCC      4501
AGGCACCTGC CTGGGGGAGG GGCTTCTCTT CCTTATGGCC TGGCCATCTA GATTGTTTAA      4561
AGTTGTGCTG ACAGCTTTTT TTGGTTTTTT GGTTTTTGTT TTTGTTTTTG TTTTGTTTTT      4621
TGTCTACTTT TGGTATTCAC AACAGCCAGG GACTTGATTT TGATGTATTT TAAGCCACAT      4681
TAAATAAAGA GTCTGTTGCC TTAAAAAAA AAAAAAAAAA A      4722

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(2) INFORMATION FOR SEQ ID NO:15:

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 1928 base pairs
- (B) TYPE: nucleic acid
- (C) STRANDEDNESS: single
- (D) TOPOLOGY: linear

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:15:

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GACGCCTCAG AGCGGAACAG GGAAGTGAAT CAGGCGCCGG GTAGTGGGTT GCTGGGCTGG      60
GCTTGCTGAG GTAGAGGCAG CGCCAAGAAG AGGCCTTTGC CGCTGGTCGG GATTGGG      117
ATG TCG AAG AAC ACA GTG TCG TCG GCC CGC TTC CGG AAG GTG GAC GTG      165
Met Ser Lys Asn Thr Val Ser Ser Ala Arg Phe Arg Lys Val Asp Val
  1             5             10             15

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GAT GAA TAT GAC GAG AAC AAG TTC GTG GAC GAA GAA GAT GGG GGC GAC Asp Glu Tyr Asp Glu Asn Lys Phe Val Asp Glu Glu Asp Gly Gly Asp 20 25 30	213
GGC CAG GCC GGG CCC GAC GAG GGC GAG GTG GAC TCC TGC CTG CGG CAA Gly Gln Ala Gly Pro Asp Glu Gly Glu Val Asp Ser Cys Leu Arg Gln 35 40 45	261
GGA AAC ATG ACA GCT GCC CTA CAG GCA GCT CTG AAG AAC CCC CCT ATC Gly Asn Met Thr Ala Ala Leu Gln Ala Ala Leu Lys Asn Pro Pro Ile 50 55 60	309
AAC ACC AAG AGT CAG GCA GTG AAG GAC CGG GCA GGC AGC ATT GTC TTG Asn Thr Lys Ser Gln Ala Val Lys Asp Arg Ala Gly Ser Ile Val Leu 65 70 75 80	357
AAG GTG CTC ATC TCT TTT AAA GCT AAT GAT ATA GAA AAG GCA GTT CAA Lys Val Leu Ile Ser Phe Lys Ala Asn Asp Ile Glu Lys Ala Val Gln 85 90 95	405
TCT CTG GAC AAG AAT GGT GTG GAT CTC CTA ATG AAG TAT ATT TAT AAA Ser Leu Asp Lys Asn Gly Val Asp Leu Leu Met Lys Tyr Ile Tyr Lys 100 105 110	453
GGA TTT GAG AGC CCG TCT GAC AAT AGC AGT GCT ATG TTA CTG CAA TGG Gly Phe Glu Ser Pro Ser Asp Asn Ser Ser Ala Met Leu Leu Gln Trp 115 120 125	501
CAT GAA AAG GCA CTT GCT GCT GGA GGA GTA GGG TCC ATT GTT CGT GTC His Glu Lys Ala Leu Ala Ala Gly Gly Val Gly Ser Ile Val Arg Val 130 135 140	549
TTG ACT GCA AGA AAA ACT GTG TAGTCTGGCA GGAAGTGGAT TATCTGCCTC Leu Thr Ala Arg Lys Thr Val 145 150	600
GGGAGTGGGA ATTGCTGGTA CAAAGACCAA AACAACCAAA TGCCACCGCT GCCCTGTGGG	660
TAGCATCTGT TTCTCTCAGC TTTGCCTTCT TGCTTTTTTCA TATCTGTAAA GAAAAAATT	720
ACATATCAGT TGTCCCTTTA ATGAAAATTG GGATAATATA GAAGAAATTG TGTAAAATA	780
GAAGTGTTTC ATCCTTTCAA AACCATTTC A GTGATGTTTA TACCAATCTG TATATAGTAT	840
AATTTACATT CAAGTTTTAA TTGTGCAACT TTTAACCCTG TTGGCTGGTT TTTGGTTCTG	900
TTTGGTTTTG TATTATTTTT AACTAATACT GAAAAATTTG GTCAGAATTT GAGGCCAGTT	960
TCCTAGCTCA TTGCTAGTCA GGAAATGATA TTTATAAAAA ATATGAGAGA CTGGCAGCTA	1020
TTAACATTGC AAAACTGGAC CATATTTCCC TTATTTAATA AGCAAAATAT GTTTTTGGAA	1080
TAAGTGGTGG GTGAATACCA CTGCTAAGTT ATAGCTTTGT TTTTGCTTGC CTCCTCATTA	1140
TCTGTACTGT GGGTTTAAGT ATGCTACTTT CTCTCAGCAT CCAATAATCA TGGCCCCCTCA	1200
ATTTATTTGT GGTCACGCAG GGTTCAGAGC AAGAAGTCTT GCTTTATACA AATGTATCCA	1260

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TAAAATATCA GAGCTTGTTG GGCATGAACA TCAAACCTTTT GTTCCACTAA TATGGCTCTG      1320
TTTGGAAGAAA ACTGCAAATC AGAAAGAATG ATTTGCAGAA AGAAAGAAAA ACTATGGTGT      1380
AATTTAAACT CTGGGCAGCC TCTGAATGAA ATGCTACTTT CTTTAGAAAT ATAATAGCTG      1440
CCTTAGACAT TATGAGGTAT ACAACTAGTA TTTAAGATAC CATTTAATAT GCCCCGTAAA      1500
TGTCTTCAGT GTTCTTCAGG GTAGTTGGGA TCTCAAAAGA TTTGGTTCAG ATCCAAACAA      1560
ATACACATTC TGTGTTTTAG CTCAGTGTTT TCTAAAAAAA GAAACTGCCA CACAGCAAAA      1620
AATTGTTTAC TTTGTTGGAC AAACCAAATC AGTTCTCAAA AAATGACCGG TGCTTATAAA      1680
AAGTTATAAA TATCGAGTAG CTCTAAAACA AACCACCTGA CCAAGAGGGA AGTGAGCTTG      1740
TGCTTAGTAT TTACATTGGA TGCCAGTTTT GTAATCACTG ACTTATGTGC AACTGGTGC      1800
AGAAATTCTA TAAACTCTTT GCTGTTTTTG ATACCTGCTT TTTGTTTCAT TTTGTTTTGT      1860
TTTGTAAGAAA TGATAAACT TCAGAAAATA AAATGTCAGT GTTGAATAAT TAAAAA      1920
AAAAA
                                         1925

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(2) INFORMATION FOR SEQ ID NO:16:

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 1207 base pairs
- (B) TYPE: nucleic acid
- (C) STRANDEDNESS: single
- (D) TOPOLOGY: linear

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:16:

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GAA GAG CGA GTA CTT GAG AAA GAA GAG GAA GAA GAT GAT GAT GAA GAT      48
Glu Glu Arg Val Leu Glu Lys Glu Glu Glu Glu Asp Asp Asp Glu Asp
  1              5              10              15

GAA GAT GAA GAA GAT GAT GTG TCA GAG GGC TCT GAA GTG CCC GAG AGT      96
Glu Asp Glu Glu Asp Asp Val Ser Glu Gly Ser Glu Val Pro Glu Ser
          20              25              30

GAC CGT CCT GCA GGT GCC CAG CAC CAC CAG CTT AAC GGC GAG CGG GGA      144
Asp Arg Pro Ala Gly Ala Gln His His Gln Leu Asn Gly Glu Arg Gly
          35              40              45

CCT CAG AGT GCC AAG GAG AGG GTC AAG GAG TGG ACC CCC TGC GGA CCG      192
Pro Gln Ser Ala Lys Glu Arg Val Lys Glu Trp Thr Pro Cys Gly Pro
          50              55              60

CAC CAG GGC CAG GAT GAA GGG CGG GGG CCA GCC CCG GGC AGC GGC ACC      240
His Gln Gly Gln Asp Glu Gly Arg Gly Pro Ala Pro Gly Ser Gly Thr
          65              70              75              80

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CGC CAG GTG TTC TCC ATG GCA GCC ATG AAC AAG GAA GGG GGA ACA GCT	288
Arg Gln Val Phe Ser Met Ala Ala Met Asn Lys Glu Gly Gly Thr Ala	
85 90 95	
TCT GTT GCC ACC GGG CCA GAC TCC CCG TCC CCC GTG CCT TTG CCC CCA	336
Ser Val Ala Thr Gly Pro Asp Ser Pro Ser Pro Val Pro Leu Pro Pro	
100 105 110	
GGC AAA CCA GCC CTA CCT GGG GCC GAC GGG ACC CCC TTT GGC TGT CCT	384
Gly Lys Pro Ala Leu Pro Gly Ala Asp Gly Thr Pro Phe Gly Cys Pro	
115 120 125	
CCC GGG CGC AAA GAG AAG CCA TCT GAT CCC GTC GAG TGG ACC GTG ATG	432
Pro Gly Arg Lys Glu Lys Pro Ser Asp Pro Val Glu Trp Thr Val Met	
130 135 140	
GAT GTC GTC GAA TAT TTT ACT GAG GCT GGA TTC CCG GAG CAG GCG ACA	480
Asp Val Val Glu Tyr Phe Thr Glu Ala Gly Phe Pro Glu Gln Ala Thr	
145 150 155 160	
GCT TTC CAA GAG CAG GAA ATT GAT GGC AAA TCT TTG CTG CTC ATG CAG	528
Ala Phe Gln Glu Gln Glu Ile Asp Gly Lys Ser Leu Leu Leu Met Gln	
165 170 175	
CGC ACA GAT GTG CTC ACC GGC CTG TCC ATC CGC CTC GGG CCA GCC CTG	576
Arg Thr Asp Val Leu Thr Gly Leu Ser Ile Arg Leu Gly Pro Ala Leu	
180 185 190	
AAA ATC TAC GAG CAC CAC ATC AAG GTG CTT CAG CAA GGC CAC TTT GAG	624
Lys Ile Tyr Glu His His Ile Lys Val Leu Gln Gln Gly His Phe Glu	
195 200 205	
GAT GAT GAC CCC GAT GGC TTC TTA GGC TGAGCGCCCA GCCTCACCCC	671
Asp Asp Asp Pro Asp Gly Phe Leu Gly	
210 215	
TGCCCCAGCC CATTCCGGCC CCCATCTCAC CCAAGATCCC CCAGAGTCCA GGAGCTGGAC	731
GGGGACACCC TCAGCCCTCA TAACAGATTC CAAGGAGAGG GCACCCTCTT GTCCTTATCT	791
TTGCCCCCTTG TGTCTGTCTC ACACACATCT GCTCCTCAGC ACGTCGGTGT GGGGAGGGGA	851
TTGCTCCTTA AACCCAGGT GGCTGACCCT CCCACCCAG TCCAGGACAT TTTAGGAAAA	911
AAAAAATGAA ATGTGGGGGG CTTCTCATCT CCCCAAGATC CTCTTCCGTT CAGCCAGATG	971
TTTCCTGTAT AAATGTTTGG ATCTGCCTGT TTATTTTGGT GGGTGGTCTT TCCTCCCTCC	1031
CCTACCACCC ATGCCCCCT TCTCAGTCTG CCCCTGGCCT CCAGCCCCTA GGGGACTAGC	1091
TGGGTGGGG TTCCTCGGGC CTTTTCTCTC CTCCCTCTTT TCTTTCTGTT GATTGTCGCT	1151
CCAGCTGGCT GTATTGCTTT TTAATATTGC ACCGAAGGTT TTTTAAATAA AATTTTA	1208

(2) INFORMATION FOR SEQ ID NO:17:

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 4697 bases
 (B) TYPE: nucleic acid
 (C) STRANDEDNESS: single
 (D) TOPOLOGY: linear

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:17:

CA AAA AGC AGC CCA GGA CAA CCG GAA GCA GGA CCC GAG GGA GCC CAG	47
Lys Ser Ser Pro Gly Gln Pro Glu Ala Gly Pro Glu Gly Ala Gln	
1 5 10 15	
GAG CGG CCC AGC CAG GCG GCT CCT GCA GTA GAA GCA GAA GGT CCC GGC	95
Glu Arg Pro Ser Gln Ala Ala Pro Ala Val Glu Ala Glu Gly Pro Gly	
20 25 30	
AGC AGC CAG GCT CCT CGG AAG CCG GAG GGG GCT CAA GCC AGA ACG GCT	143
Ser Ser Gln Ala Pro Arg Lys Pro Glu Gly Ala Gln Ala Arg Thr Ala	
35 40 45	
CAG TCT GGG GCC CTT CGT GAT GTC TCT GAG GAG CTG AGC CGC CAA CTG	191
Gln Ser Gly Ala Leu Arg Asp Val Ser Glu Glu Leu Ser Arg Gln Leu	
50 55 60	
GAA GAC ATA CTG AGC ACA TAC TGT GTG GAC AAT AAC CAG GGG GGC CCC	239
Glu Asp Ile Leu Ser Thr Tyr Cys Val Asp Asn Asn Gln Gly Gly Pro	
65 70 75	
GGC GAG GAT GGG GCA CAG GGT GAG CCG GCT GAA CCC GAA GAT GCA GAG	287
Gly Glu Asp Gly Ala Gln Gly Glu Pro Ala Glu Pro Glu Asp Ala Glu	
80 85 90 95	
AAG TCC CGG ACC TAT GTG GCA AGG AAT GGG GAG CCT GAA CCA ACT CCA	335
Lys Ser Arg Thr Tyr Val Ala Arg Asn Gly Glu Pro Glu Pro Thr Pro	
100 105 110	
GTA GTC TAT GGA GAG AAG GAA CCC TCC AAG GGG GAT CCA AAC ACA GAA	383
Val Val Tyr Gly Glu Lys Glu Pro Ser Lys Gly Asp Pro Asn Thr Glu	
115 120 125	
GAG ATC CGG CAG AGT GAC GAG GTC GGA GAC CGA GAC CAT CGA AGG CCA	431
Glu Ile Arg Gln Ser Asp Glu Val Gly Asp Arg Asp His Arg Arg Pro	
130 135 140	
CAG GAG AAG AAA AAA GCC AAG GGT TTG GGG AAG GAG ATC ACG TTG CTG	479
Gln Glu Lys Lys Lys Ala Lys Gly Leu Gly Lys Glu Ile Thr Leu Leu	
145 150 155	
ATG CAG ACA TTG AAT ACT CTG AGT ACC CCA GAG GAG AAG CTG GCT GCT	527
Met Gln Thr Leu Asn Thr Leu Ser Thr Pro Glu Glu Lys Leu Ala Ala	
160 165 170 175	
CTG TGC AAG AAG TAT GCT GAA CTG CTG GAG GAG CAC CGG AAT TCA CAG	575
Leu Cys Lys Lys Tyr Ala Glu Leu Leu Glu Glu His Arg Asn Ser Gln	
180 185 190	

AAG CAG ATG AAG CTC CTA CAG AAA AAG CAG AGC CAG CTG GTG CAA GAG Lys Gln Met Lys Leu Leu Gln Lys Lys Gln Ser Gln Leu Val Gln Glu 195 200 205	623
AAG GAC CAC CTG CGC GGT GAG CAC AGC AAG GCC GTC CTG GCC CGC AGC Lys Asp His Leu Arg Gly Glu His Ser Lys Ala Val Leu Ala Arg Ser 210 215 220	671
AAG CTT GAG AGC CTA TGC CGT GAG CTG CAG CGG CAC AAC CGC TCC CTC Lys Leu Glu Ser Leu Cys Arg Glu Leu Gln Arg His Asn Arg Ser Leu 225 230 235	719
AAG GAA GAA GGT GTG CAG CGG GCC CGG GAG GAG GAG GAG AAG CGC AAG Lys Glu Glu Gly Val Gln Arg Ala Arg Glu Glu Glu Glu Lys Arg Lys 240 245 250 255	767
GAG GTG ACC TCG CAC TTC CAG GTG ACA CTG AAT GAC ATT CAG CTG CAG Glu Val Thr Ser His Phe Gln Val Thr Leu Asn Asp Ile Gln Leu Gln 260 265 270	815
ATG GAA CAG CAC AAT GAG CGC AAC TCC AAG CTG CGC CAA GAG AAC ATG Met Glu Gln His Asn Glu Arg Asn Ser Lys Leu Arg Gln Glu Asn Met 275 280 285	863
GAG CTG GCT GAG AGG CTC AAG AAG CTG ATT GAG CAG TAT GAG CTG CGC Glu Leu Ala Glu Arg Leu Lys Lys Leu Ile Glu Gln Tyr Glu Leu Arg 290 295 300	911
GAG GAG CAT ATC GAC AAA GTC TTC AAA CAC AAG GAC CTA CAA CAG CAG Glu Glu His Ile Asp Lys Val Phe Lys His Lys Asp Leu Gln Gln Gln 305 310 315	959
CTG GTG GAT GCC AAG CTC CAG CAG GCC CAG GAG ATG CTA AAG GAG GCA Leu Val Asp Ala Lys Leu Gln Gln Ala Gln Glu Met Leu Lys Glu Ala 320 325 330 335	1007
GAA GAG CGG CAC CAG CGG GAG AAG GAT TTT CTC CTG AAA GAG GCA GTA Glu Glu Arg His Gln Arg Glu Lys Asp Phe Leu Leu Lys Glu Ala Val 340 345 350	1055
GAG TCC CAG AGG ATG TGT GAG CTG ATG AAG CAG CAA GAG ACC CAC CTG Glu Ser Gln Arg Met Cys Glu Leu Met Lys Gln Gln Glu Thr His Leu 355 360 365	1103
AAG CAA CAG CTT GCC CTA TAC ACA GAG AAG TTT GAG GAG TTC CAG AAC Lys Gln Gln Leu Ala Leu Tyr Thr Glu Lys Phe Glu Glu Phe Gln Asn 370 375 380	1151
ACA CTT TCC AAA AGC AGC GAG GTA TTC ACC ACA TTC AAG CAG GAG ATG Thr Leu Ser Lys Ser Ser Glu Val Phe Thr Thr Phe Lys Gln Glu Met 385 390 395	1199
GAA AAG ATG ACT AAG AAG ATC AAG AAG CTG GAG AAA GAA ACC ACC ATG Glu Lys Met Thr Lys Lys Ile Lys Lys Leu Glu Lys Glu Thr Thr Met 400 405 410 415	1247

TAC CGG TCC CGG TGG GAG AGC AGC AAC AAG GCC CTG CTT GAG ATG GCT Tyr Arg Ser Arg Trp Glu Ser Ser Asn Lys Ala Leu Leu Glu Met Ala 420 425 430	1295
GAG GAG AAA ACA GTC CGG GAT AAA GAA CTG GAG GGC CTG CAG GTA AAA Glu Glu Lys Thr Val Arg Asp Lys Glu Leu Glu Gly Leu Gln Val Lys 435 440 445	1343
ATC CAA CGG CTG GAG AAG CTG TGC CGG GCA CTG CAG ACA GAG CGC AAT Ile Gln Arg Leu Glu Lys Leu Cys Arg Ala Leu Gln Thr Glu Arg Asn 450 455 460	1391
GAC CTG AAC AAG AGG GTA CAG GAC CTG AGT GCT GGT GGC CAG GGC TCC Asp Leu Asn Lys Arg Val Gln Asp Leu Ser Ala Gly Gly Gln Gly Ser 465 470 475	1439
CTC ACT GAC AGT GGC CCT GAG AGG AGG CCA GAG GGG CCT GGG GCT CAA Leu Thr Asp Ser Gly Pro Glu Arg Arg Pro Glu Gly Pro Gly Ala Gln 480 485 490 495	1487
GCA CCC AGC TCC CCC AGG GTC ACA GAA GCG CCT TGC TAC CCA GGA GCA Ala Pro Ser Ser Pro Arg Val Thr Glu Ala Pro Cys Tyr Pro Gly Ala 500 505 510	1535
CCG AGC ACA GAA GCA TCA GGC CAG ACT GGG CCT CAA GAG CCC ACC TCC Pro Ser Thr Glu Ala Ser Gly Gln Thr Gly Pro Gln Glu Pro Thr Ser 515 520 525	1583
GCC AGG GCC TAGAGAGCCT GGTGTTGGGT CATGCTGGGA AGGGAGCGGC AGCCCAGCCA Ala Arg Ala 530	1642
GGCCTGGCCC ATAAAAGGCT CCCATGCTGA GCAGCCCAT T GCTGAAGCCA GGATGTTCTT	1702
GACCTGGCTG GCATCTGGCA CTTGCAATTT TGGATTTTGT GGGTCAGTTT TACGTACATA	1762
GGGCATTTTG CAAGGCCTTG CAAATGCATT TATACCTGTA AGTGTACAGT GGGCTTGCAT	1822
TGGGGATGGG GGTGTGTACA GATGAAGTCA GTGGCTTGTC TGTGAGCTGA AGAGTCTTGA	1882
GAGGGGCTGT CATCTGTAGC TGCCATCACA GTGAGTTGGC AGAAGTGA CT TGAGCATTTT	1942
TCTGTCTGAT TTGAGGCTCA GACCCCTCCC TGCCCTTTCA GAGCTCAAAA CAAGTAATAC	2002
ACCAAGGTCT TGA CTGCATT TGTCTTGTGA GCAGGGCTTG CTTGGTCAGC TCAGGCCCTC	2062
CTAGCTGCTT GGAGGCTCCT TTGATTCTCT AGACCTGGAA AAGGTGTCCC TAGGCAGAGC	2122
CCTGGCAGGG CGCTCAGAGC TGGGATTTCC TGCCTGGAAC AAGGGACCTG GAGAATGTTT	2182
TTGCGTGGGA TGATGTGCTG GTCAGGAGCC CCTTGGGCAT CGCTTCCCCT GCCCTTTGGT	2242
AGTGCCAGGA CCAGGCCAAT GATGCTTCTC AGTAGCCTTA TCATTCACAG GTGCCTCTCT	2302
AGCCTGCACA AATGATTGAC AAGAGATCAC CCAAAGGATT ATTTCTGAAG GTGTTTTTTT	2362
CTTTATTTCT TTTTCTTTTT TTTTTTTTCT TTTTCTTTTT TTTTTCACACA TGACAGTGTT	2422

TGTATTGAGG ACCTTCCAAG GAAAAGGGAT GCTGTACCAG TGGTGCCTGG GTGCCTGGCC	2482
TCCAGTGTCC CACCTCCTTC ACCACCCAC TTGGCTCCTT TGCCATCTTG ATGCTGAGGT	2542
TTCCTGTTTG GTGAGATCAG GTTGTTTGTG GTAAAAGAAA GGAAAGGGCT TCTGATGGCT	2602
TTGCCACAAG CTTACCTGTG GGTTCAGTC CTGAGAGGCC ACCACCAGTT CCCATCAGCA	2662
CTGTCTCCAT GCAGCAGTTG CTGGGTCCCA TGTCCAGCTG CCTCTTGGC TTCATGGGTT	2722
TTTCTGCTTC CTGCCCCAC CCCCACATGT GCAATCCTCA AGATTTGTCC TGATTCTATT	2782
TCCTGGCACC TCCCTGCCTG TCCTTGGGA TTCTACTTCT TCCTGTGTGG GGCCCATAGC	2842
TGTTGTCTAA CAGGTAAGAA ATGAAATTGA ACTATTGACT GGGCCCCAGA AATCCATAAA	2902
ATGGCTGCAG ACAGTTGTTT CTGTGTCCTG TTCTACCCCC ACTCCAGTAC ATAACTACTA	2962
TGTACTGTGT AGAGCCATTC TATATGCTGA ATGTTCTGCT GTTGCAAAC TGCAGGGTA	3022
TTAGCCAGTG TTTGTGCCAA GCAGTTTTCG GGGACAACAG AATGACTCAG ACCAAGATGG	3082
ATAGGATGGT TAGGGCTTTG CTTCTTGCTG TTTTCTTTG AACTAGTCAT TGTCCTGCAG	3142
GTCCCTTCAT CTTCCATACC TAGCCCACTC TTTTAGCCCT TACCTTAAAT CTCTCAGATA	3202
AGTTGGTTCA CAAAGAATGT TAAGTACTGA ATCATGTGTG ACTGAGACCA GAGATGGCAA	3262
ATGAATGGCA CACCATTTCT CTTCTCCTG CCCCAGGGCA GGTACCACTG ATCTGCATCA	3322
GAGTTGCCTG CTATTCTCTG GTGTATCCTT CACATCTAGG TGCCCTCAAG CAGCTGTGTG	3382
AGTGTTGAGA TCTCTGCCAT CTCTGGCTGA GATACTGCTG TCCTGTGAAG TGTTTCCCAT	3442
GACCTTTTTT TTCCCCTTTG AATCCCTCTT GTCTGGAGTA GTCCTGCCT TCTTCTTGCT	3502
CCAGTAGGCC TTTTCCTTAC CCCAGCCCTT GTGCCAGGCT AAGCTGGTAC AAGAGCTGCC	3562
AACTCACAGA GTTTTGCTAG GCGAGAGAGG TGCAGGGAAG AGGCAGAGGT ATGCACCTTC	3622
CCCCTGAAG AGAGGGGAAA GGCCTACAGT GGCCACATA ATTGCCTGAC TCACACTTCA	3682
GCTACCTCTT AATGCCTGTG GAGGGACTGG AGCTGCTGGA TCCCAGTGTG GTGGTGTAGG	3742
AGGCCACAGT GAGCAGGTGG CCCCAGCTGG GTTTCCAGG TCAGGAATGT GGGCCCCAGG	3802
CAAGGTGCAG CCTTTGCTCA CAGCTCCATC CATGTCTAGA CCTTCAGGCC AGTCTGCAGA	3862
TGAGGTTCCC TACCTTTTTT TTCTCTTCAT TGACCAAATC AACCAATCAC TACAGCTGCT	3922
CTGCTTCTGC TTTCCAAAGT AGCCCAGGTC CTGGGCCAGA TGCAGGGGAG GTGCCTATCC	3982
ATGAGTGAAG GCCAGTGTCT TCCTCACCTG GGTGGTCCCA CACTTGTGAC CCTCAGTTTT	4042
AGGACCCAAG ATCTGTGTTG GTTTCTTAGA TTGCTAGCTT TTCCTCCAGG GGACCACAGC	4102
AGGTGAAGCT CAAGAGCGCA TGGCTCTGCT AATAGTAAAT TGTTTTCAGG GCCTTGTC	4162

GCTGAGAGCT TCATGTCCAC CAGATTCTGA GAGGTGTCAG CAGCACTTTT TTTTTTTATT	4222
TGTTGTTTGT TTTCCATGAG GTTATCGGAC CATGGGCTGA GCTCAGGCAC TTTCTGTAGG	4282
A3ACTGTTAT TTCTGTAAAG ATGGTTATTT AACCCCTCCTC CACCCCATCA CGGTGGCCCT	4342
GAGGGCTGAC CCGGAGGCCA GTGGAGCTGC CTGGTGTCCA CGGGGGAGGG CCAAGGCCTG	4402
CTGAGCTGAT TCTCCAGCTG CTGCCCCAGC CTTTCCGCCT TGCACAGCAC AGAGGTGGTC	4462
ACCCAGGGA CAGCCAGGCA CCTGCTCCTC TTGCCCTTCC TGGGGGAAAG GAGCTGCCTT	4522
CTGTCCCTGT AACTGCTTTC CTTATGGCCC AACCCGCCA CTCAGACTTG TTTGAAGCTG	4582
CACTGGCAGC TTTTTTGTCT CCTTTGGGTA TTCACAACAG CCAGGGACTT GATTTTGATG	4642
TATTTTAAAC CACATTAAAT AAAGAGTCTG TTGCCTTAAA AAAAAAAAAA AAAAA	4697

(2) INFORMATION FOR SEQ ID NO:18:

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 60 base pairs
- (B) TYPE: nucleic acid
- (C) STRANDEDNESS: single
- (D) TOPOLOGY: linear

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:18:

GTG GAC GTG GAT GAG TAC GAC GAG AAC AAG TTC GTG GAC GAG GAA GAC	48
Val Asp Val Asp Glu Tyr Asp Glu Asn Lys Phe Val Asp Glu Glu Asp	
1 5 10 15	
GGC GGC GAC GGC	60
Gly Gly Asp Gly	
20	

(2) INFORMATION FOR SEQ ID NO:19:

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 15 amino acids
- (B) TYPE: amino acid
- (D) TOPOLOGY: linear

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:19:

Glu Glu Glu Glu Asp Asp Asp Glu Asp Glu Asp Glu Glu Asp Asp	
1 5 10 15	

(2) INFORMATION FOR SEQ ID NO:20:

(i) SEQUENCE CHARACTERISTICS:

(A) LENGTH: 26 amino acids

(B) TYPE: amino acid

(D) TOPOLOGY: linear

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:20:

Glu	Glu	Glu	Glu	Asp	Asp	Asp	Glu	Asp	Glu	Asp	Glu	Glu	Asp	Asp	Val
1				5				10					15		
Ser	Glu	Gly	Ser	Glu	Val	Pro	Glu	Ser	Asp						
			20					25							

(2) INFORMATION FOR SEQ ID NO:21:

(i) SEQUENCE CHARACTERISTICS:

(A) LENGTH: 11 amino acids

(B) TYPE: amino acid

(D) TOPOLOGY: linear

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:21:

Val	Ser	Glu	Gly	Ser	Glu	Val	Pro	Glu	Ser	Asp
1				5					10	

(2) INFORMATION FOR SEQ ID NO:22:

(i) SEQUENCE CHARACTERISTICS:

(A) LENGTH: 10 amino acids

(B) TYPE: amino acid

(D) TOPOLOGY: linear

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:22:

Glu	Asp	Asp	Asp	Pro	Asp	Gly	Phe	Leu	Gly
1				5					10

(2) INFORMATION FOR SEQ ID NO:23:

(i) SEQUENCE CHARACTERISTICS:

(A) LENGTH: 30 amino acids

(B) TYPE: amino acid

(D) TOPOLOGY: linear

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:23:

Val Asp Val Asp Glu Tyr Asp Glu Asn Lys Phe Val Asp Glu Glu Asp
 1 5 10 15

Gly Gly Asp Gly Gln Ala Gly Pro Asp Glu Gly Glu Val Asp
 20 25 30

(2) INFORMATION FOR SEQ ID NO:24:

(i) SEQUENCE CHARACTERISTICS:

(A) LENGTH: 6 amino acids

(B) TYPE: amino acid

(D) TOPOLOGY: linear

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:24:

Asp Glu Gly Glu Val Asp
 1 5

(2) INFORMATION FOR SEQ ID NO:25:

(i) SEQUENCE CHARACTERISTICS:

(A) LENGTH: 16 amino acids

(B) TYPE: amino acid

(D) TOPOLOGY: linear

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:25:

Glu Glu Glu Glu Glu Glu Glu Glu Asp Asp Glu Asp Asp Asp Asp Asp
 1 5 10 15

(2) INFORMATION FOR SEQ ID NO:26:

(i) SEQUENCE CHARACTERISTICS:

(A) LENGTH: 28 amino acids

(B) TYPE: amino acid

(D) TOPOLOGY: linear

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:26:

Glu Glu Glu Glu Glu Glu Glu Glu Asp Asp Glu Asp Asp Asp Asp Asp
 1 5 10 15

Val Val Ser Glu Gly Ser Glu Val Pro Glu Ser Asp
 20 25

(2) INFORMATION FOR SEQ ID NO:27:

(i) SEQUENCE CHARACTERISTICS:

(A) LENGTH: 12 amino acids

-83-

- (B) TYPE: amino acid
(D) TOPOLOGY: linear

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:27:

Val	Val	Ser	Glu	Gly	Ser	Glu	Val	Pro	Glu	Ser	Asp
1				5					10		

(2) INFORMATION FOR SEQ ID NO:28:

- (i) SEQUENCE CHARACTERISTICS:
 (A) LENGTH: 10 amino acids
 (B) TYPE: amino acid
 (D) TOPOLOGY: linear

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:28:

Pro	Pro	Gly	Lys	Pro	Ala	Leu	Pro	Gly	Ala
1				5				10	

(2) INFORMATION FOR SEQ ID NO:29:

- (i) SEQUENCE CHARACTERISTICS:
 (A) LENGTH: 15 amino acids
 (B) TYPE: amino acid
 (D) TOPOLOGY: linear

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:29:

Glu	Asp	Gly	Val	Gln	Gly	Glu	Pro	Pro	Glu	Pro	Glu	Asp	Ala	Glu
1				5					10					15

(2) INFORMATION FOR SEQ ID NO:30:

- (i) SEQUENCE CHARACTERISTICS:
 (A) LENGTH: 45 bases
 (B) TYPE: nucleic acid
 (C) STRANDEDNESS: single
 (D) TOPOLOGY: linear

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:30:

GAA	GAG	GAA	GAA	GAT	GAT	GAT	GAA	GAT	GAA	GAT	GAA	GAA	GAT	GAT
Glu	Glu	Glu	Glu	Asp	Asp	Asp	Glu	Asp	Glu	Asp	Glu	Glu	Asp	Asp
1				5				10					15	

45

(2) INFORMATION FOR SEQ ID NO:31:

- (i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 78 bases
- (B) TYPE: nucleic acid
- (C) STRANDEDNESS: single
- (D) TOPOLOGY: linear

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:31:

GAA GAG GAA GAA GAT GAT GAT GAA GAT GAA GAT GAA GAA GAT GAT GTG	45
Glu Glu Glu Glu Asp Asp Asp Glu Asp Glu Asp Glu Glu Asp Asp Val	
1 5 10 15	
TCA GAG GGC TCT GAA GTG CCC GAG AGT GAC	78
Ser Glu Gly Ser Glu Val Pro Glu Ser Asp	
20 25	

(2) INFORMATION FOR SEQ ID NO:32:

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 33 bases
- (B) TYPE: nucleic acid
- (C) STRANDEDNESS: single
- (D) TOPOLOGY: linear

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:32:

GTG TCA GAG GGC TCT GAA GTG CCC GAG AGT GAC	33
Val Ser Glu Gly Ser Glu Val Pro Glu Ser Asp	
1 5 10	

(2) INFORMATION FOR SEQ ID NO:33:

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 30 bases
- (B) TYPE: nucleic acid
- (C) STRANDEDNESS: single
- (D) TOPOLOGY: linear

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:33:

GAG GAT GAT GAC CCC GAT GGC TTC TTA GGC	30
Glu Asp Asp Asp Pro Asp Gly Phe Leu Gly	
1 5 10	

(2) INFORMATION FOR SEQ ID NO:34:

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 90 bases
- (B) TYPE: nucleic acid
- (C) STRANDEDNESS: single
- (D) TOPOLOGY: linear

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:34:

GTG	GAC	GTG	GAT	GAA	TAT	GAC	GAG	AAC	AAG	TTC	GTG	GAC	GAA	GAA	GAT	48
Val	Asp	Val	Asp	Glu	Tyr	Asp	Glu	Asn	Lys	Phe	Val	Asp	Glu	Glu	Asp	
1				5					10					15		
GGG	GGC	GAC	GGC	CAG	GCC	GGG	CCC	GAC	GAG	GGC	GAG	GTG	GAC			90
Gly	Gly	Asp	Gly	Gln	Ala	Gly	Pro	Asp	Glu	Gly	Glu	Val	Asp			
			20					25					30			

(2) INFORMATION FOR SEQ ID NO:35:

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 18 bases
- (B) TYPE: nucleic acid
- (C) STRANDEDNESS: single
- (D) TOPOLOGY: linear

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:35:

GAC	GAG	GGC	GAG	GTG	GAC	18
Asp	Glu	Gly	Glu	Val	Asp	
1				5		

(2) INFORMATION FOR SEQ ID NO:36:

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 48 bases
- (B) TYPE: nucleic acid
- (C) STRANDEDNESS: single
- (D) TOPOLOGY: linear

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:36:

GAG	GAG	GAG	GAG	GAG	GAG	GAG	GAG	GAA	GAC	GAC	GAG	GAC	GAC	GAC	GAC	GAC	48
Glu	Glu	Glu	Glu	Glu	Glu	Glu	Glu	Glu	Asp	Asp	Glu	Asp	Asp	Asp	Asp	Asp	
1					5				10						15		

(2) INFORMATION FOR SEQ ID NO:37:

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 84 bases
- (B) TYPE: nucleic acid
- (C) STRANDEDNESS: single
- (D) TOPOLOGY: linear

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:37:

GAG	GAG	GAG	GAG	GAG	GAG	GAG	GAG	GAA	GAC	GAC	GAG	GAC	GAC	GAC	GAC	GAC	48
Glu	Glu	Glu	Glu	Glu	Glu	Glu	Glu	Glu	Asp	Asp	Glu	Asp	Asp	Asp	Asp	Asp	
1					5				10						15		

GTC GTG TCC GAG GGC TCG GAG GTG CCC GAG AGC GAT
 Val Val Ser Glu Gly Ser Glu Val Pro Glu Ser Asp
 20 25

84

(2) INFORMATION FOR SEQ ID NO:38:

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 36 bases
- (B) TYPE: nucleic acid
- (C) STRANDEDNESS: single
- (D) TOPOLOGY: linear

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:38:

GTC GTG TCC GAG GGC TCG GAG GTG CCC GAG AGC GAT
 Val Val Ser Glu Gly Ser Glu Val Pro Glu Ser Asp
 1 5 10

36

(2) INFORMATION FOR SEQ ID NO:39:

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 30 bases
- (B) TYPE: nucleic acid
- (C) STRANDEDNESS: single
- (D) TOPOLOGY: linear

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:39:

CCC CCC GGG AAG CCA GCC CTC CCA GGA GCC
 Pro Pro Gly Lys Pro Ala Leu Pro Gly Ala
 1 5 10

30

(2) INFORMATION FOR SEQ ID NO:40:

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 45 bases
- (B) TYPE: nucleic acid
- (C) STRANDEDNESS: single
- (D) TOPOLOGY: linear

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:40:

GAG GAT GGG GTC CAG GGT GAG CCC CCT GAA CCT GAA GAT GCA GAG
 Glu Asp Gly Val Gln Gly Glu Pro Pro Glu Pro Glu Asp Ala Glu
 1 5 10 15

45

(2) INFORMATION FOR SEQ ID NO:41:

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 7 amino acids

(B) TYPE: amino acid
(D) TOPOLOGY: linear

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:41:

Arg Asp Val Ser Glu Glu Leu
1 5

(2) INFORMATION FOR SEQ ID NO:42:

(i) SEQUENCE CHARACTERISTICS:

(A) LENGTH: 21 bases
(B) TYPE: nucleic acid
(C) STRANDEDNESS: single
(D) TOPOLOGY: linear

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:42:

CGT GAT GTC TCT GAG GAG CTG
Arg Asp Val Ser Glu Glu Leu
1 5

21

CLAIMS

1. An isolated polynucleotide comprising a member selected from the group consisting of:

(a) a polynucleotide encoding the polypeptide comprising the amino acid sequence as set forth in SEQ ID NO:1;

(b) a polynucleotide encoding the polypeptide comprising the amino acid sequence as set forth in SEQ ID NO:2;

(c) a polynucleotide encoding the polypeptide comprising the amino acid sequence as set forth in SEQ ID NO:3;

(d) a polynucleotide encoding the polypeptide comprising the amino acid sequence as set forth in SEQ ID NO:4;

(e) a polynucleotide encoding the polypeptide comprising the amino acid sequence as set forth in SEQ ID NO:5;

(f) a polynucleotide encoding the polypeptide comprising the amino acid sequence as set forth in SEQ ID NO:6;

(g) a polynucleotide encoding the polypeptide comprising the amino acid sequence as set forth in SEQ ID NO:7;

(h) a polynucleotide encoding the polypeptide comprising the amino acid sequence as set forth in SEQ ID NO:8;

(i) a polynucleotide encoding the polypeptide comprising the amino acid sequence as set forth in SEQ ID NO:9;

(j) a polynucleotide capable of hybridizing to and which is at least about 95% identical to the polynucleotide of (a)-(h) or (i) wherein the encoded polypeptide is capable of binding to LDL; and

(k) a biologically active fragment of polynucleotide (a)-(i) or (j) wherein the encoded polypeptide is capable of binding to LDL.

2. An isolated polynucleotide of claim 1 wherein said member is selected from the group consisting of:

(a) a polynucleotide encoding the polypeptide comprising the amino acid residues 8-22 (SEQ ID NO:19), 8-33 (SEQ ID NO:20), 23-33 (SEQ ID NO:21) or 208-217 (SEQ ID NO:22) of the amino acid sequence as set forth in SEQ ID NO:7;

(b) a polynucleotide encoding the polypeptide comprising the amino acid residues 14-43 (SEQ ID NO:23) or 38-43 (SEQ ID NO:24) of the amino acid sequence as set forth in SEQ ID NO:1 and SEQ ID NO:6;

(c) a polynucleotide encoding the polypeptide comprising the amino acid residues 105-120 (SEQ ID NO:25), 105-132 (SEQ ID NO:26), 121-132 (SEQ ID NO:27) or 211-220 (SEQ ID NO:28) of the amino acid sequence as set forth in SEQ ID NO:2;

(d) a polynucleotide encoding the polypeptide comprising the amino acid residues 96-110 (SEQ ID NO:29) of the amino acid sequence as set forth in SEQ ID NO:5;

(e) a polynucleotide encoding the polypeptide comprising the amino acid residues 53-59 (SEQ ID NO:41) of the amino acid sequence as set forth in SEQ ID NO:8;

(f) a polynucleotide capable of hybridizing to and which is at least about 95% identical to the polynucleotide of (a)-(d) or (e) wherein the encoded polypeptide is capable of binding to LDL; and

(g) a biologically active fragment of polynucleotide (a)-(e) or (f) wherein the encoded polypeptide is capable of binding to LDL.

3. The polynucleotide of claim 1 wherein said polynucleotide comprises the nucleic acid as set forth in SEQ ID NO:10.

20 4. The polynucleotide of claim 1 wherein said polynucleotide comprises the nucleic acid as set forth in SEQ ID NO:11.

5. The polynucleotide of claim 1 wherein said polynucleotide comprises the nucleic acid as set forth in SEQ ID NO:12.

25

6. The polynucleotide of claim 1 wherein said polynucleotide comprises the nucleic acid as set forth in SEQ ID NO:13.

7. The polynucleotide of claim 1 wherein said polynucleotide comprises the nucleic acid as set forth in SEQ ID NO:14.

30

8. The polynucleotide of claim 1 wherein said polynucleotide comprises the nucleic acid as set forth in SEQ ID NO:15.

9. The polynucleotide of claim 1 wherein said polynucleotide comprises the nucleic acid
5 as set forth in SEQ ID NO:16.

10. The polynucleotide of claim 1 wherein said polynucleotide comprises the nucleic acid as set forth in SEQ ID NO:17.

10 11. The polynucleotide of claim 1 wherein said polynucleotide comprises the nucleic acid as set forth in SEQ ID NO:18.

12. The polynucleotide of claim 2 wherein said polynucleotide comprises the nucleic acid as set forth in SEQ ID NO:30.

15

13. The polynucleotide of claim 2 wherein said polynucleotide comprises the nucleic acid as set forth in SEQ ID NO:31.

14. The polynucleotide of claim 2 wherein said polynucleotide comprises the nucleic
20 acid as set forth in SEQ ID NO:32.

15. The polynucleotide of claim 2 wherein said polynucleotide comprises the nucleic acid as set forth in SEQ ID NO:33.

25 16. The polynucleotide of claim 2 wherein said polynucleotide comprises the nucleic acid as set forth in SEQ ID NO:34.

17. The polynucleotide of claim 2 wherein said polynucleotide comprises the nucleic acid as set forth in SEQ ID NO:35.

30

18. The polynucleotide of claim 2 wherein said polynucleotide comprises the nucleic acid as set forth in SEQ ID NO:36.

19. The polynucleotide of claim 2 wherein said polynucleotide comprises the nucleic acid as set forth in SEQ ID NO:37.

20. The polynucleotide of claim 2 wherein said polynucleotide comprises the nucleic acid as set forth in SEQ ID NO:38.

21. The polynucleotide of claim 2 wherein said polynucleotide comprises the nucleic acid as set forth in SEQ ID NO:39.

22. The polynucleotide of claim 2 wherein said polynucleotide comprises the nucleic acid as set forth in SEQ ID NO:40.

23. The polypeptide of claim 2 wherein said polynucleotide comprises the nucleic acid as set forth in SEQ ID NO:42.

24. The polynucleotide of claim 1 wherein said polynucleotide is selected from the group consisting of DNA and RNA.

25. The polynucleotide of claim 1 wherein said polynucleotide is genomic DNA.

26. A recombinant vector comprising said polynucleotide of claim 1.

27. A cell comprising said recombinant vector of claim 26.

28. A method for producing an LDL binding protein comprising culturing a cell of claim 27 under conditions that permit expression of said LDL binding protein.

29. An isolated polypeptide comprising a member selected from the group consisting of:

(a) a polypeptide having the amino acid sequence as set forth in SEQ ID NO:1;

(b) a polypeptide having the amino acid sequence as set forth in SEQ ID NO:2;

(c) a polypeptide having the amino acid sequence as set forth in SEQ ID NO:3;

(d) a polypeptide having the amino acid sequence as set forth in SEQ ID NO:4;

- (e) a polypeptide having the amino acid sequence as set forth in SEQ ID NO:5;
(f) a polypeptide having the amino acid sequence as set forth in SEQ ID NO:6;
(g) a polypeptide having the amino acid sequence as set forth in SEQ ID NO:7;
(h) a polypeptide having the amino acid sequence as set forth in SEQ ID NO:8;
5 (i) a polypeptide having the amino acid sequence as set forth in SEQ ID NO:9;
(j) a polypeptide which is at least about 95% identical to the polypeptide of (a)-(h) or (i)
wherein said polypeptide is capable of binding to LDL; and
(k) a biologically active fragment of polypeptide (a)-(i) or (j) wherein said fragment is
capable of binding to LDL.

10

30. An isolated polypeptide of claim 29 wherein said member is selected from the group consisting of:

- (a) a polypeptide having the amino acid residues 8-22 (SEQ ID NO:19), 8-33 (SEQ ID NO:20), 23-33 (SEQ ID NO:21) or 208-217 (SEQ ID NO:22) of the amino acid sequence as set
15 forth in SEQ ID NO:7;
(b) a polypeptide having the amino acid residues 14-43 (SEQ ID NO:23) or 38-43 (SEQ ID NO:24) of the amino acid sequence as set forth in SEQ ID NO:1 and SEQ ID NO:6;
(c) a polypeptide having the amino acid residues 105-120 (SEQ ID NO:25), 105-132 (SEQ ID NO:26), 121-132 (SEQ ID NO:27) or 211-220 (SEQ ID NO:28) of the amino acid
20 sequence as set forth in SEQ ID NO:2;
(d) a polypeptide having the amino acid residues 96-110 (SEQ ID NO:29) of the amino acid sequence as set forth in SEQ ID NO:5;
(e) a polypeptide having the amino acid residues 53-59 (SEQ ID NO:41) of the amino acid sequence as set forth in SEQ ID NO:8;
25 (f) a polypeptide which is at least about 95% identical to the polypeptide of (a)-(d) or (e)
wherein said polypeptide is capable of binding to LDL; and
(g) a biologically active fragment of polypeptide (a)-(e) or (f) wherein said fragment is
capable of binding to LDL.

30

31. A method for determining if an animal is at risk for atherosclerosis, comprising:
providing an animal; and
evaluating an aspect of LBP metabolism or structure in said animal, an abnormality in

said aspect of LBP metabolism or structure being diagnostic of being at risk for atherosclerosis.

32. The method of claim 31 wherein said LBP is selected from the group consisting of LBP-1, LBP-2 and LBP-3.

5

33. The method of claim 31 wherein said aspect of LBP metabolism is the ability of said LBP to bind to LDL.

34. The method of claim 31 wherein said aspect of LBP metabolism is the ability of said
10 LBP to bind to an arterial extracellular matrix structural component.

35. The method of claim 34 wherein said component is selected from the group consisting of proteoglycans, elastin, collagen, fibronectin, vitronectin and integrins.

15 36. The method of claim 31 wherein said risk is a reduced risk as compared to a normal animal.

37. The method of claim 36 wherein said abnormality results in an inactive LBP polypeptide.

20

38. The method of claim 31 wherein said risk is an increased risk as compared to a normal animal.

39. The method of claim 38 wherein said abnormality results in an LBP polypeptide that
25 has higher activity than native LBP polypeptide.

40. The method of claim 31 wherein said animal is a prenatal animal.

41. A method for evaluating an agent for use in treating atherosclerosis, comprising:
30 providing a test cell, cell-free system or animal;
providing an agent;
administering said agent to said test cell, cell-free system or animal in a therapeutically

effective amount; and

evaluating the effect of said agent on an aspect of LBP metabolism or structure, a change in said aspect of LBP metabolism or structure being indicative of the usefulness of said agent in treating atherosclerosis.

5

42. The method of claim 41 wherein said test cell, cell-free system or animal has a wild type pattern of LBP metabolism.

43. The method of claim 41 wherein said test cell, cell-free system or animal has a non-
10 wild type pattern of LBP metabolism.

44. The method of claim 41 wherein said LBP is selected from the group consisting of LBP-1, LBP-2 and LBP-3.

15 45. The method of claim 41 wherein said agent comprises LBP-1, LBP-2 or LBP-3 polypeptide or a biologically active fragment or analog thereof.

46. The method of claim 41 wherein said agent is selected from the group consisting of a polypeptide comprising an amino acid sequence as set forth in Figs. 1-8 and 9 (SEQ ID NOS:1-
20 9).

47. The method of claim 41 wherein said agent comprises a nucleic acid encoding LBP-1, LBP-2 or LBP-3 polypeptide or a biologically active fragment or analog thereof.

25 48. The method of claim 41 wherein said agent is selected from the group consisting of a nucleic acid comprising a nucleotide sequence as set forth in Figs. 10-17 and 18 (SEQ ID NOS:10-18).

49. The method of claim 41 wherein said agent comprises a nucleic acid encoding an
30 LBP regulatory sequence or a biologically active fragment thereof.

50. The method of claim 41 wherein said agent is selected from the group consisting of a binding molecule for said LBP polypeptide and a binding molecule for said LBP nucleic acid.

51. The method of claim 41 wherein said agent is an antisense nucleic acid or analog
5 thereof.

52. The method of claim 41 wherein said agent is selected from the group consisting of a mimetic of said LBP and a mimetic of a binding molecule of said LBP.

10 53. The method of claim 41 wherein said agent is a polyclonal or monoclonal antibody, or fragment thereof, that can immunoreact with an LBP polypeptide.

54. The method of claim 41 wherein said agent is selected from the group consisting of a natural antibody, a recombinant antibody, a chimeric antibody and a humanized antibody that
15 can immunoreact with an LBP polypeptide.

55. The method of claim 41 wherein said agent is a natural ligand for said LBP.

56. The method of claim 41 wherein said agent is an artificial ligand for said LBP.
20

57. The method of claim 41 wherein said agent is selected from the group consisting of an antagonist, an agonist and a super agonist.

58. The method of claim 41 wherein said agent is administered to a member selected
25 from the group consisting of a transgenic cell and a transgenic animal.

59. The method of claim 41 wherein said agent is administered to said test cell or cell-free system in vitro, and if said change in said aspect of said LBP metabolism occurs, then further administering said agent to a test animal in a therapeutically effective amount and
30 evaluating the in vivo effect of said agent on an aspect of LBP metabolism.

60. The agent identified in claim 41.

61. A method for evaluating an agent for the ability to alter the binding of LBP polypeptide to a binding molecule, comprising:

providing an agent;

providing LBP polypeptide;

5 providing a binding molecule;

combining said agent, said LBP polypeptide and said binding molecule; and

detecting the formation of a complex comprising said LBP polypeptide and said binding molecule, an alteration in the formation of said complex in the presence of said agent as compared to in the absence of said agent being indicative of said agent altering the binding of
10 said LBP polypeptide to said binding molecule.

62. The method of claim 61 wherein said LBP polypeptide is selected from the group consisting of LBP-1, LBP-2 and LBP-3 polypeptide.

15 63. The method of claim 61 wherein the altering of the binding of said LBP polypeptide to said binding molecule is inhibiting the binding.

64. The method of claim 61 wherein the altering of the binding of said LBP polypeptide to said binding molecule is promoting the binding.

20

65. The method of claim 61 wherein said binding molecule is selected from the group consisting of native LDL and modified LDL.

66. The method of claim 61 wherein said binding molecule is an arterial extracellular
25 matrix structural component.

67. The agent identified in claim 61.

68. A method for evaluating an agent for the ability to bind to an LBP polypeptide,
30 comprising:

providing an agent;

providing an LBP polypeptide;

contacting said agent with said LBP polypeptide; and
evaluating the ability of said agent to bind to said LBP polypeptide.

69. The method of claim 68 wherein said LBP polypeptide is selected from the group
5 consisting of LBP-1, LBP-2 and LBP-3 polypeptide.

70. The agent identified in claim 68.

71. A method for evaluating an agent for the ability to bind to a nucleic acid encoding an
10 LBP regulatory sequence, comprising:
providing an agent;
providing a nucleic acid encoding an LBP regulatory sequence;
contacting said agent with said nucleic acid; and
evaluating the ability of said agent to bind to said nucleic acid.

15 72. The method of claim 71 wherein said LBP regulatory sequence is selected from the
group consisting of LBP-1, LBP-2 and LBP-3.

73. The agent identified in claim 71.

20 74. A method for treating atherosclerosis in an animal, comprising:
providing an animal in need of treatment for atherosclerosis;
providing an agent capable of altering an aspect of LBP structure or metabolism;
administering said agent to said animal in a therapeutically effective amount such that
25 treatment of said atherosclerosis occurs.

75. The method of claim 74 wherein said agent is an LBP polypeptide.

76. The method of claim 75 wherein said LBP polypeptide is LBP-1, LBP-2 or LBP-3
30 polypeptide or a biologically active fragment or analog thereof.

77. The method of claim 76 wherein said agent is selected from the group consisting of a polypeptide comprising an amino acid sequence as set forth in SEQ ID NOS:1-8 and 9.

78. The method of claim 76 wherein said agent is selected from the group consisting of a
5 polypeptide comprising amino acid residues 8-22 (SEQ ID NO:19), 8-33 (SEQ ID NO:20), 23-
33 (SEQ ID NO:21) or 208-217 (SEQ ID NO:22) of human LBP-2 as depicted in SEQ ID NO:7;
amino acid residues 14-43 (SEQ ID NO:23) or 38-43 (SEQ ID NO:24) of rabbit or human LBP-1
as depicted in SEQ ID NO:1 and SEQ ID NO:6; amino acid residues 105-120 (SEQ ID NO:25),
105-132 (SEQ ID NO:26), 121-132 (SEQ ID NO:27) or 211-220 (SEQ ID NO:28) of rabbit
10 LBP-2 as depicted in SEQ ID NO:2; amino acid residues 96-110 (SEQ ID NO:29) of rabbit
LBP-3 as depicted in SEQ ID NO:5; and amino acid residues 53-59 (SEQ ID NO:41) as set forth
in SEQ ID NO:8.

79. The method of claim 74 wherein said agent is a polypeptide of no more than about
15 50 amino acid residues in length.

80. The method of claim 74 wherein said agent is a polypeptide having an amino acid
sequence that includes at least about 20% acidic amino acid residues.

20 81. The method of claim 74 wherein said agent is selected from the group consisting of a
homopolymer of an acidic amino acid or analog thereof, and a heteropolymer of one or more
acidic amino acids and one or more other amino acids or analogs thereof.

82. The method of claim 74 wherein said agent is selected from the group consisting of
25 poly(glu), poly(asp) and poly(glu asp).

83. The method of claim 74 wherein said agent is selected from the group consisting of
poly(glu N), poly(asp N) and poly(glu asp N).

30 84. The method of claim 74 wherein said agent is poly(glu) of no more than about 10
amino acid residues in length.

85. The method of claim 74 wherein said agent is an LBP nucleic acid or a biologically active fragment or analog thereof.

86. The method of claim 85 wherein said LBP nucleic acid comprises a nucleic acid
5 encoding LBP-1, LBP-2 or LBP-3 polypeptide or a biologically active fragment or analog thereof.

87. The method of claim 86 wherein said agent is selected from the group consisting of a nucleic acid comprising a nucleotide sequence as set forth in SEQ ID NOS:10-17 and 18.

10

88. The method of claim 74 wherein said agent is an antisense nucleic acid or analog thereof.

15

89. A method for treating an animal at risk for atherosclerosis, comprising:
providing an animal at risk for atherosclerosis;
providing an agent capable of altering an aspect of LBP structure or metabolism; and
administering said agent to said animal in a therapeutically effective amount such that
treatment of said animal occurs.

20

90. A method for treating a cell having an abnormality in structure or metabolism of LBP, comprising:

25

providing a cell having an abnormality in structure or metabolism of LBP;
providing an agent capable of altering an aspect of LBP structure or metabolism; and
administering said agent to said cell in a therapeutically effective amount such that
treatment of said cell occurs.

91. The method of claim 90 wherein said LBP is selected from the group consisting of LBP-1, LBP-2 and LBP-3.

30

92. The method of claim 90 wherein said cell is obtained from a cell culture or tissue culture.

93. The method of claim 90 wherein said cell is obtained from an embryo fibroblast.

94. The method of claim 90 wherein said cell is part of an animal.

5 95. The method of claim 94 wherein said animal is a non-human transgenic animal.

96. A pharmaceutical composition for treating atherosclerosis in an animal, comprising:
a therapeutically effective amount of an agent, said agent being capable of altering an
aspect of LBP metabolism or structure in said animal so as to result in treatment of said
10 atherosclerosis; and
a pharmaceutically acceptable carrier.

97. The pharmaceutical composition of claim 96 wherein said agent is an LBP
polypeptide or nucleic acid, or biologically active fragment or analog thereof.

15 98. The pharmaceutical composition of claim 96 wherein said agent is a polypeptide of
no more than about 50 amino acid residues in length.

99. The pharmaceutical composition of claim 96 wherein said agent is a polypeptide
20 having an amino acid sequence that includes at least about 20% acidic amino acid residues.

100. A vaccine composition for treating atherosclerosis in an animal, comprising:
a therapeutically effective amount of an agent, said agent being capable of altering an
aspect of LBP metabolism or structure in said animal so as to result in treatment of said
25 atherosclerosis; and
a pharmaceutically acceptable carrier.

101. A method for diagnosing atherosclerotic lesions in an animal, comprising:
providing an animal;
30 providing a labeled agent capable of binding to LBP present in atherosclerotic lesions;
administering said labeled agent to said animal under conditions which allow said labeled
agent to interact with said LBP so as to result in labeled LBP; and

determining the localization or quantification of said labeled LBP by imaging so as to diagnose the presence of atherosclerotic lesions in said animal.

102. The method of claim 101 wherein said LBP is selected from the group consisting of
5 LBP-1, LBP-2 and LBP-3.

103. The method of claim 101 wherein said imaging is selected from the group consisting of magnetic resonance imaging, gamma camera imaging, single photon emission computed tomographic (SPECT) imaging and positron emission tomography (PET).
10

104. A method for immunizing an animal against an LBP or fragment or analog thereof, comprising:

providing an animal having LDL;

providing an LBP or fragment or analog thereof;

15 administering said LBP or fragment or analog thereof to said animal so as to stimulate antibody production by said animal to said LBP or fragment or analog thereof such that binding of said LBP to said LDL is altered.

105. The method of claim 104 wherein binding of said LBP to said LDL is decreased.
20

106. A method of making a fragment or analog of LBP polypeptide, said fragment or analog having the ability to bind to modified LDL and native LDL, comprising:

providing an LBP polypeptide;

altering the sequence of said LBP polypeptide; and

25 testing said altered LBP polypeptide for the ability to bind to modified LDL and native LDL.

107. The method of claim 106 wherein said LBP is selected from the group consisting of LBP-1, LBP-2 and LBP-3.
30

108. The method of claim 106 wherein said altered LBP polypeptide is selected from the group consisting of an antagonist, an agonist and a super agonist.

109. A method for isolating a cDNA encoding an LBP, comprising:
providing a cDNA library;

screening said cDNA library for a cDNA encoding a polypeptide which binds to native
LDL and modified LDL; and

5 isolating said cDNA which encodes said polypeptide, said cDNA encoding an LBP.

met ser lys asn thr
val ser ser ala arg phe arg lys val asp val asp
glu tyr asp glu asn lys phe val asp glu glu asp
gly gly asp gly gln ala gly pro asp glu gly glu
val asp ser cys leu arg gln gly asn met thr ala
ala leu gln ala ala leu lys asn pro pro ile asn
thr **arg** ser gln ala val lys asp arg ala gly ser
ile val leu lys val leu ile ser phe lys ala **gly**
asp ile glu lys ala val gln ser leu asp **arg** asn
gly val asp leu leu met lys tyr ile tyr lys gly
phe glu ser pro ser asp asn ser ser ala **val** leu
leu gln trp his glu lys ala leu ala ala gly gly
val gly ser ile val arg val leu thr ala arg lys
thr val

asp cys arg ser ser ser asn asn arg Xaa pro lys
gly gly ala ala arg ala gly gly pro ala arg pro
val ser leu arg glu val val arg tyr leu gly gly
ser ser gly ala gly gly arg leu thr arg gly arg
val gln gly leu leu glu glu glu ala ala ala arg
gly arg leu glu arg thr arg leu gly ala leu ala
leu pro arg gly asp arg pro gly arg ala pro pro
ala ala ser ala arg ala ala arg asn lys arg ala
gly glu glu arg val leu glu lys glu glu glu glu
glu glu glu glu asp **asp glu asp asp asp asp**
val val ser glu gly ser glu val pro glu ser asp
arg pro ala gly ala gln his his gln leu asn **gly**
gly glu arg gly pro gln **thr** ala lys glu arg **ala**
lys glu trp **ser leu** cys gly pro his **pro** gly gln
glu glu gly arg gly pro ala **ala** gly ser gly thr
arg gln val phe ser met ala ala **leu ser** lys glu
gly gly **ser** ala ser **ser thr** thr gly pro asp ser
pro ser pro val pro leu pro pro gly lys pro ala
leu pro gly ala asp gly thr pro phe gly cys pro
ala gly arg lys glu lys pro **ala** asp pro val glu
trp thr val met asp val val glu tyr phe thr glu
ala gly phe pro glu gln ala thr ala phe gln glu
gln glu ile asp gly lys ser leu leu leu met gln
arg thr asp val leu thr gly leu ser ile arg leu
gly pro ala leu lys ile tyr glu his his ile lys
val leu gln gln gly his phe glu asp asp asp pro
glu gly phe leu gly

ala ser ala arg ala ala arg asn lys arg ala
gly glu glu arg val leu glu lys glu glu glu glu
glu glu glu glu asp **asp glu asp asp** asp asp **asp**
val val ser glu gly ser glu val pro glu ser asp
arg pro ala gly ala gln his his gln leu asn **gly**
gly glu arg gly pro gln **thr** ala lys glu arg **ala**
lys glu trp **ser leu** cys gly pro his **pro** gly gln
glu glu gly arg gly pro ala **ala** gly ser gly thr
arg gln val phe ser met ala ala **leu ser** lys glu
gly gly **ser** ala ser **ser thr** thr gly pro asp ser
pro ser pro val pro leu pro pro gly lys pro ala
leu pro gly ala asp gly thr pro phe gly cys pro
ala gly arg lys glu lys pro **ala** asp pro val glu
trp thr val met asp val val glu tyr phe thr glu
ala gly phe pro glu gln ala thr ala phe gln glu
gln glu ile asp gly lys ser leu leu leu met gln
arg thr asp val leu thr gly leu ser ile arg leu
gly pro ala leu lys ile tyr glu his his ile lys
val leu gln gln gly his phe glu asp asp asp pro
glu gly phe leu gly

thr arg leu gly ala leu ala
leu pro arg gly asp arg pro gly arg ala pro pro
ala ala ser ala arg ala ala arg asn lys arg ala
gly glu glu arg val leu glu lys glu glu glu glu
glu glu glu glu asp asp glu asp asp asp asp
val val ser glu gly ser glu val pro glu ser asp
arg pro ala gly ala gln his his gln leu asn gly
gly glu arg gly pro gln thr ala lys glu arg ala
lys glu trp ser leu cys gly pro his pro gly gln
glu glu gly arg gly pro ala ala gly ser gly thr
arg gln val phe ser met ala ala leu ser lys glu
gly gly ser ala ser ser thr thr gly pro asp ser
pro ser pro val pro leu pro pro gly lys pro ala
leu pro gly ala asp gly thr pro phe gly cys pro
ala gly arg lys glu lys pro ala asp pro val glu
trp thr val met asp val val glu tyr phe thr glu
ala gly phe pro glu gln ala thr ala phe gln glu
gln glu ile asp gly lys ser leu leu leu met gln
arg thr asp val leu thr gly leu ser ile arg leu
gly pro ala leu lys ile tyr glu his his ile lys
val leu gln gln gly his phe glu asp asp asp pro
glu gly phe leu gly

met lys asn gln
asp lys lys asn gly ala ala lys gln pro asn pro
lys ser ser pro gly gln pro glu ala gly **ala** glu
gly ala gln **gly** arg pro **gly** **arg** **pro** ala pro ala
arg glu ala glu gly **ala** ser ser gln ala pro **gly**
arg pro glu gly ala gln ala **lys** thr ala gln **pro**
gly ala leu **cys** asp val ser glu glu leu ser arg
gln leu glu asp ile leu ser thr tyr cys val asp
asn asn gln gly **ala** pro gly glu asp gly **val** gln
gly glu pro **pro** glu pro glu asp ala glu lys ser
arg **ala** tyr val ala arg asn gly glu pro glu pro
gly thr pro val val **asn** gly glu lys glu **thr** ser
lys **ala** **glu** pro **gly** thr glu glu ile arg **thr** ser
asp glu val gly asp arg asp his arg arg pro gln
glu lys lys lys ala lys gly leu gly lys glu ile
thr leu leu met gln thr leu asn thr leu ser thr
pro glu glu lys leu ala ala leu cys lys lys tyr
ala glu leu leu glu glu his arg asn ser gln lys
gln met lys leu leu gln lys lys gln ser gln leu
val gln glu lys asp his leu arg gly glu his ser
lys ala **ile** leu ala arg ser lys leu glu ser leu
cys arg glu leu gln arg his asn arg ser leu lys
glu glu gly val gln arg ala arg glu glu glu glu
lys arg lys glu val thr ser his phe gln **met** thr
leu asn asp ile gln leu gln met glu gln his asn
glu arg asn ser lys leu arg gln glu asn met glu
leu ala glu arg leu lys lys leu ile glu gln tyr
glu leu arg glu glu his ile asp lys val phe lys
his lys asp leu gln gln gln leu val asp ala lys
leu gln gln ala gln glu met leu lys glu ala glu
glu arg his gln arg glu lys asp phe leu leu lys
glu ala val glu ser gln arg met cys glu leu met

lys gln gln glu thr his leu lys gln gln leu ala
leu tyr thr glu lys phe glu glu phe gln asn thr
leu ser lys ser ser glu val phe thr thr phe lys
gln glu met glu lys met thr lys lys ile lys lys
leu glu lys glu thr thr met tyr arg ser arg trp
glu ser ser asn lys ala leu leu glu met ala glu
glu lys thr leu arg asp lys glu leu glu gly leu
gln val lys ile gln arg leu glu lys leu cys arg
ala leu gln thr glu arg asn asp leu asn lys arg
val gln asp leu ser ala gly gly gln gly pro val
ser asp ser gly pro glu arg arg pro glu pro ala
thr thr ser lys glu gln gly val glu gly pro gly
ala gln val pro asn ser pro arg ala thr asp ala
ser cys cys ala gly ala pro ser thr glu ala ser
gly gln thr gly pro gln glu pro thr thr ala thr
ala

met ser lys asn thr val ser ser ala
arg phe arg lys val asp val asp glu tyr asp glu
asn lys phe val asp glu glu asp gly gly asp gly
gln ala gly pro asp glu gly glu val asp ser cys
leu arg gln gly asn met thr ala ala leu gln ala
ala leu lys asn pro pro ile asn thr **lys** ser gln
ala val lys asp arg ala gly ser ile val leu lys
val leu ile ser phe lys ala **asn** asp ile glu lys
ala val gln ser leu asp **lys** asn gly val asp leu
leu met lys tyr ile tyr lys gly phe glu ser pro
ser asp asn ser ser ala **met** leu leu gln trp his
glu lys ala leu ala ala gly gly val gly ser ile
val arg val leu thr ala arg lys thr val

glu glu arg val leu glu lys glu glu glu glu asp
asp asp glu asp glu asp glu glu asp asp val ser
glu gly ser glu val pro glu ser asp arg pro ala
gly ala gln his his gln leu asn gly glu arg gly
pro gln ser ala lys glu arg val lys glu trp thr
pro cys gly pro his gln gly gln asp glu gly arg
gly pro ala pro gly ser gly thr arg gln val phe
ser met ala ala met asn lys glu gly gly thr ala
ser val ala thr gly pro asp ser pro ser pro val
pro leu pro pro gly lys pro ala leu pro gly ala
asp gly thr pro phe gly cys pro pro gly arg lys
glu lys pro ser asp pro val glu trp thr val met
asp val val glu tyr phe thr glu ala gly phe pro
glu gln ala thr ala phe gln glu gln glu ile asp
gly lys ser leu leu leu met gln arg thr asp val
leu thr gly leu ser ile arg leu gly pro ala leu
lys ile tyr glu his his ile lys val leu gln gln
gly his phe glu asp asp asp pro asp gly phe leu
gly

lys ser ser pro gly gln pro glu ala gly pro glu gly ala
gln glu arg pro ser gln ala ala pro ala val glu ala glu gly
pro gly ser ser gln ala pro arg lys pro glu gly ala gln ala
arg thr ala gln ser gly ala leu arg asp val ser glu glu leu
ser arg gln leu glu asp ile leu ser thr tyr cys val asp asn
asn gln gly gly pro gly glu asp gly ala gln gly glu pro ala
glu pro glu asp ala glu lys ser arg thr tyr val ala arg asn
gly glu pro glu pro thr pro val val tyr gly glu lys glu pro
ser lys gly asp pro asn thr glu glu ile arg gln ser asp glu
val gly asp arg asp his arg arg pro gln glu lys lys lys ala
lys gly leu gly lys glu ile thr leu leu met gln thr leu asn
thr leu ser thr pro glu glu lys leu ala ala leu cys lys lys
tyr ala glu leu leu glu glu his arg asn ser gln lys gln met
lys leu leu gln lys lys gln ser gln leu val gln glu lys asp
his leu arg gly glu his ser lys ala val leu ala arg ser lys
leu glu ser leu cys arg glu leu gln arg his asn arg ser leu
lys glu glu gly val gln arg ala arg glu glu glu glu lys arg
lys glu val thr ser his phe gln val thr leu asn asp ile gln
leu gln met glu gln his asn glu arg asn ser lys leu arg gln
glu asn met glu leu ala glu arg leu lys lys leu ile glu gln
tyr glu leu arg glu glu his ile asp lys val phe lys his lys
asp leu gln gln gln leu val asp ala lys leu gln gln ala gln
glu met leu lys glu ala glu glu arg his gln arg glu lys asp
phe leu leu lys glu ala val glu ser gln arg met cys glu leu
met lys gln gln glu thr his leu lys gln gln leu ala leu tyr
thr glu lys phe glu glu phe gln asn thr leu ser lys ser ser
glu val phe thr thr phe lys gln glu met glu lys met thr lys
lys ile lys lys leu glu lys glu thr thr met tyr arg ser arg
trp glu ser ser asn lys ala leu leu glu met ala glu glu lys

thr val arg asp lys glu leu glu gly leu gln val lys ile gln
arg leu glu lys leu cys arg ala leu gln thr glu arg asn asp
leu asn lys arg val gln asp leu ser ala gly gly gln gly ser
leu thr asp ser gly pro glu arg arg pro glu gly pro gly ala
gln ala pro ser ser pro arg val thr glu ala pro cys tyr pro
gly ala pro ser thr glu ala ser gly gln thr gly pro gln glu
pro thr ser ala arg ala ***

val asp val asp

glu tyr asp glu asn lys phe val asp glu glu asp

gly gly asp gly

721	TGT	AAG	ACC	CCT	GCC	TTC	AGT	GTC	CTT	GAG	CAA	CGG
757	TAG	CGT	GTC	GCC	GGC	TGG	GTT	TGG	TTT	TGT	CGT	GGA
793	GGG	ATC	TGG	TCA	GAA	TTT	GAG	GCC	AGT	TTC	CTA	ACT
829	CAT	TGC	TGG	TCA	GGA	AAT	GAT	CTT	CAT	TTA	AAA	AAA
865	AAA	AAA	AGA	CTG	GCA	GCT	ATT	ATG	CAA	AAC	TGG	ACC
901	CTC	TTC	CCT	TAT	TTA	AGC	AGA	GTG	AGT	TTC	TGG	AAC
937	CAG	TGG	TGC	CCC	CCC	CCC	CGC	CCC	GGC	CGC	CGT	CCT
973	GCT	CAA	GGG	AAG	CCT	CCC	TGC	AGA	GCA	GCA	GAG	CCC
1009	CTG	GGC	AGG	AGC	GCC	GCG	TCC	CGC	TCC	CAG	GAG	ACA
1045	GCA	TGC	GCG	GTC	ACG	CGG	CAC	TTC	CTG	TGC	CTC	CCA
1081	GCC	CCA	GTG	CCC	CGG	AGT	TCT	TCA	GGG	CGA	CAG	GGA
1117	CCT	CAG	AAG	ACT	GGA	TCC	GAT	CCA	GAC	AGA	CGC	CCA
1153	TTC	TTG	GTT	CAG	CTC	AGT	GTT	TTC	AAA	AGG	AAC	GTG
1189	CTA	CCG	TGG	GTA	GAG	CAC	ACT	GGT	TCT	CAG	AAC	ACG
1225	GCC	GGC	GCT	TGA	CGG	TTG	TCA	CAG	CTC	CAG	AAC	AAA
1261	TCC	TGG	GAG	ACA	GGC	GAG	CGC	GAG	TCG	CCG	GGC	AGG
1297	AAT	TCC	ACA	CAC	TCG	TGC	TGT	TTT	TGA	TAC	CTG	CTT
1333	TTT	GTT	TTG	TTT	TGT	AAA	AAT	GAT	GCA	CTT	GAG	AAA
1369	ATA	AAA	CGT	CAG	TGT	TGA	CAA	AAA	AAA	AAA	AAA	AAA

1 GAC TGC CGC AGC AGC AGC AAC AAC CGC TAG CCG AAG
 asp cys arg ser ser ser asn asn arg Xaa pro lys

 37 GGT GGC GCG GCG CGG GCC GGC GGC CCG GCG CGG CCC
 gly gly ala ala arg ala gly gly pro ala arg pro

 73 GTG AGC CTG CGG GAA GTC GTG CGC TAC CTC GGG GGT
 val ser leu arg glu val val arg tyr leu gly gly

 109 AGC AGC GGC GCT GGC GGC CGC CTG ACC CGC GGC CGC
 ser ser gly ala gly gly arg leu thr arg gly arg

 145 GTG CAG GGT CTG CTG GAA GAG GAG GCG GCG GCG CGG
 val gln gly leu leu glu glu glu ala ala ala arg

 181 GGC CGC CTG GAG CGC ACC CGT CTC GGA GCG CTT GCG
 gly arg leu glu arg thr arg leu gly ala leu ala

 217 CTG CCC CGC GGG GAC AGG CCC GGA CGG GCG CCA CCG
 leu pro arg gly asp arg pro gly arg ala pro pro

 253 GCC GCC AGC GCC CGC GCG GCG CGG AAC AAG AGA GCT
 ala ala ser ala arg ala ala arg asn lys arg ala

 289 GGC GAG GAG CGA GTG CTT GAA AAG GAG GAG GAG GAG
 gly glu glu arg val leu glu lys glu glu glu glu

 325 GAG GAG GAG GAA GAC GAC GAG GAC GAC GAC GAC GAC
glu glu glu glu asp **asp glu asp asp** asp asp **asp**

 361 GTC GTG TCC GAG GGC TCG GAG GTG CCC GAG AGC GAT
val val ser glu gly ser glu val pro glu ser asp

 397 CGT CCC GCG GGT GCG CAG CAT CAC CAG CTG AAT GGC
 arg pro ala gly ala gln his his gln leu asn **gly**

 433 GGC GAG CGC GGC CCG CAG ACC GCC AAG GAG CGG GCC
 gly glu arg gly pro gln **thr** ala lys glu arg **ala**

 469 AAG GAG TGG TCG CTG TGT GGC CCC CAC CCT GGC CAG
 lys glu trp **ser leu** cys gly pro his **pro** gly gln

 505 GAG GAA GGG CGG GGG CCG GCC GCG GGC AGT GGC ACC
glu glu gly arg gly pro ala **ala** gly ser gly thr

 541 CGC CAG GTG TTC TCC ATG GCG GCC TTG AGT AAG GAG
 arg gln val phe ser met ala ala **leu ser** lys glu

11/21 (continued)

577 GGG GGA TCA GCC TCT TCG ACC ACC GGG CCT GAC TCC
gly gly **ser** ala ser **ser thr** thr gly pro asp ser

613 CCG TCC CCG GTG CCT TTG CCC CCC GGG AAG CCA GCC
pro ser pro val pro leu pro pro gly lys pro ala

649 CTC CCA GGA GCC GAT GGG ACC CCC TTT GGC TGC CCT
leu pro gly ala asp gly thr pro phe gly cys pro

685 GCC GGG CGC AAA GAG AAG CCG GCA GAC CCC GTG GAG
ala gly arg lys glu lys pro **ala** asp pro val glu

721 TGG ACA GTC ATG GAC GTC GTG GAG TAC TTC ACC GAG
trp thr val met asp val val glu tyr phe thr glu

757 GCG GGC TTC CCT GAG CAA GCC ACG GCT TTC CAG GAG
ala gly phe pro glu gln ala thr ala phe gln glu

793 CAG GAG ATC GAC GGC AAG TCC CTG CTG CTC ATG CAG
gln glu ile asp gly lys ser leu leu leu met gln

829 CGC ACC GAT GTC CTC ACC GGC CTG TCC ATC CGC CTG
arg thr asp val leu thr gly leu ser ile arg leu

865 GGG CCA GCG TTG AAA ATC TAT GAG CAC CAT ATC AAG
gly pro ala leu lys ile tyr glu his his ile lys

901 GTG CTG CAG CAG GGT CAC TTC GAG GAC GAT GAC CCG
val leu gln gln gly his phe glu asp asp asp pro

937 GAA GGC TTC CTG GGA TGA GCA CAG AGC CGC CGC GCC
glu gly phe leu gly

973 CCT TGT CCC CAC CCC CAC CCC GCC TGG ACC CAT TCC

1009 TGC CTC CAT GTC ACC CAA GGT GTC CCA GAG GCC AGG

1045 AGC TGG ACT GGG CAG GCG AGG GGT GCG GAC CTA CCC

1081 TGA TTC TGG TAG GGG GCG GGG CCT TGC TGT GCT CAT

1117 TGC TAC CCC CCC ACC CCG TGT GTG TCT CTG CAC CTG

1153 CCC CCA GCA CAC CCC TCC CGG AGC CTG GAT GTC GCC

1189 TGG GAC TCT GGC CTG CTC ATT TTG CCC CCA GAT CAG

1225 CCC CCT CCC TCC CTC CTG TCC CAG GAC ATT TTT TAA

1261 AAG AAA AAA AGG AAA AAA AAA AAT TGG GGA GGG GGC

1297 TGG GAA GGT GCC CCA AGA TCC TCC TCG GCC CAA CCA

1333 GGT GTT TAT TCC TAT ATA TAT ATA TAT ATG TTT TGT

1369 TCT GCC TGT TTT TCG TTT TTT GGT GCG TGG CCT TTC

1405 TTC CCT CCC ACC ACC ACT CAT GGC CCC AGC CCT GCT

1441 CGC CCT GTC GGC GGG AGC AGC TGG GAA TGG GAG GAG

1477 GGT GGG ACC TTG GGT CTG TCT CCC ACC CTC TCT CCC

1513	GTT	GGT	TCT	GTT	GTC	GCT	CCA	GCT	GGC	TGT	ATT	GCT
1549	TTT	TAA	TAT	TGC	ACC	GAA	GGG	TTG	TTT	TTT	TTT	TTT
1585	TAA	ATA	AAA	TTT	TAA	AAA	AAG	GAA	AAA	AAA	AAA	AAA

256 GCC AGC GCC CGC GCG GCG CGG AAC AAG AGA GCT
 ala ser ala arg ala ala arg asn lys arg ala

289 GGC GAG GAG CGA GTG CTT GAA AAG GAG GAG GAG GAG
 gly glu glu arg val leu glu lys glu glu glu glu

325 GAG GAG GAG GAA GAC GAC GAG GAC GAC GAC GAC GAC
 glu glu glu glu asp asp glu asp asp asp asp asp

361 GTC GTG TCC GAG GGC TCG GAG GTG CCC GAG AGC GAT
 val val ser glu gly ser glu val pro glu ser asp

397 CGT CCC GCG GGT GCG CAG CAT CAC CAG CTG AAT GGC
 arg pro ala gly ala gln his his gln leu asn gly

433 GGC GAG CGC GGC CCG CAG ACC GCC AAG GAG CGG GCC
 gly glu arg gly pro gln thr ala lys glu arg ala

469 AAG GAG TGG TCG CTG TGT GGC CCC CAC CCT GGC CAG
 lys glu trp ser leu cys gly pro his pro gly gln

505 GAG GAA GGG CGG GGG CCG GCC GCG GGC AGT GGC ACC
 glu glu gly arg gly pro ala ala gly ser gly thr

541 CGC CAG GTG TTC TCC ATG GCG GCC TTG AGT AAG GAG
 arg gln val phe ser met ala ala leu ser lys glu

577 GGG GGA TCA GCC TCT TCG ACC ACC GGG CCT GAC TCC
 gly gly ser ala ser ser thr thr gly pro asp ser

613 CCG TCC CCG GTG CCT TTG CCC CCC GGG AAG CCA GCC
 pro ser pro val pro leu pro pro gly lys pro ala

649 CTC CCA GGA GCC GAT GGG ACC CCC TTT GGC TGC CCT
 leu pro gly ala asp gly thr pro phe gly cys pro

685 GCC GGG CGC AAA GAG AAG CCG GCA GAC CCC GTG GAG
 ala gly arg lys glu lys pro ala asp pro val glu

721 TGG ACA GTC ATG GAC GTC GTG GAG TAC TTC ACC GAG
 trp thr val met asp val val glu tyr phe thr glu

12/21 (continued)

757 GCG GGC TTC CCT GAG CAA GCC ACG GCT TTC CAG GAG
ala gly phe pro glu gln ala thr ala phe gln glu

793 CAG GAG ATC GAC GGC AAG TCC CTG CTG CTC ATG CAG
gln glu ile asp gly lys ser leu leu leu met gln

829 CGC ACC GAT GTC CTC ACC GGC CTG TCC ATC CGC CTG
arg thr asp val leu thr gly leu ser ile arg leu

865 GGG CCA GCG TTG AAA ATC TAT GAG CAC CAT ATC AAG
gly pro ala leu lys ile tyr glu his his ile lys

901 GTG CTG CAG CAG GGT CAC TTC GAG GAC GAT GAC CCG
val leu gln gln gly his phe glu asp asp asp pro

937 GAA GGC TTC CTG GGA TGA GCA CAG AGC CGC CGC GCC
glu gly phe leu gly

973 CCT TGT CCC CAC CCC CAC CCC GCC TGG ACC CAT TCC

1009 TGC CTC CAT GTC ACC CAA GGT GTC CCA GAG GCC AGG

1045 AGC TGG ACT GGG CAG GCG AGG GGT GCG GAC CTA CCC

1081 TGA TTC TGG TAG GGG GCG GGG CCT TGC TGT GCT CAT

1117 TGC TAC CCC CCC ACC CCG TGT GTG TCT CTG CAC CTG

1153 CCC CCA GCA CAC CCC TCC CGG AGC CTG GAT GTC GCC

1189 TGG GAC TCT GGC CTG CTC ATT TTG CCC CCA GAT CAG

1225 CCC CCT CCC TCC CTC CTG TCC CAG GAC ATT TTT TAA

1261 AAG AAA AAA AGG AAA AAA AAA AAT TGG GGA GGG GGC

1297 TGG GAA GGT GCC CCA AGA TCC TCC TCG GCC CAA CCA

1333 GGT GTT TAT TCC TAT ATA TAT ATA TAT ATG TTT TGT

1369 TCT GCC TGT TTT TCG TTT TTT GGT GCG TGG CCT TTC

1405 TTC CCT CCC ACC ACC ACT CAT GGC CCC AGC CCT GCT

1441 CGC CCT GTC GGC GGG AGC AGC TGG GAA TGG GAG GAG

1477 GGT GGG ACC TTG GGT CTG TCT CCC ACC CTC TCT CCC

1513 GTT GGT TCT GTT GTC GCT CCA GCT GGC TGT ATT GCT

1549 TTT TAA TAT TGC ACC GAA GGG TTG TTT TTT TTT TTT

1585 TAA ATA AAA TTT TAA AAA AAG GAA AAA AAA AAA

196 ACC CGT CTC GGA GCG CTT GCG
thr arg leu gly ala leu ala

217 CTG CCC CGC GGG GAC ACG CCC GGA CGG GCG CCA CCG
leu pro arg gly asp arg pro gly arg ala pro pro

253 GCC GCC AGC GCC CGC GCG GCG CGG AAC AAG AGA GCT
ala ala ser ala arg ala ala arg asn lys arg ala

289 GGC GAG GAG CGA GTG CTT GAA AAG GAG GAG GAG GAG
gly glu glu arg val leu glu lys glu glu glu glu

325 GAG GAG GAG GAA GAC GAC GAG GAC GAC GAC GAC GAC
glu glu glu glu asp **asp glu asp asp** asp asp **asp**

361 GTC GTG TCC GAG GGC TCG GAG GTG CCC GAG AGC GAT
val val ser glu gly ser glu val pro glu ser asp

397 CGT CCC GCG GGT GCG CAG CAT CAC CAG CTG AAT GGC
arg pro ala gly ala gln his his gln leu asn **gly**

433 GGC GAG CGC GGC CCG CAG ACC GCC AAG GAG CGG GCC
gly glu arg gly pro gln **thr** ala lys glu arg **ala**

469 AAG GAG TGG TCG CTG TGT GGC CCC CAC CCT GGC CAG
lys glu trp **ser leu** cys gly pro his **pro** gly gln

505 GAG GAA GGG CGG GGG CCG GCC GCG GGC AGT GGC ACC
glu glu gly arg gly pro ala **ala** gly ser gly thr

541 CGC CAG GTG TTC TCC ATG GCG GCC TTG AGT AAG GAG
arg gln val phe ser met ala ala **leu ser** lys glu

577 GGG GGA TCA GCC TCT TCG ACC ACC GGG CCT GAC TCC
gly gly **ser** ala ser **ser thr** thr gly pro asp ser

613 CCG TCC CCG GTG CCT TTG CCC CCC GGG AAG CCA GCC
pro ser pro val pro leu pro pro gly lys pro ala

649 CTC CCA GGA GCC GAT GGG ACC CCC TTT GGC TGC CCT
leu pro gly ala asp gly thr pro phe gly cys pro

13/21 (continued)

685 GCC GGG CGC AAA GAG AAG CCG GCA GAC CCC GTG GAG
ala gly arg lys glu lys pro ala asp pro val glu

721 TGG ACA GTC ATG GAC GTC GTG GAG TAC TTC ACC GAG
trp thr val met asp val val glu tyr phe thr glu

757 GCG GGC TTC CCT GAG CAA GCC ACG GCT TTC CAG GAG
ala gly phe pro glu gln ala thr ala phe gln glu

793 CAG GAG ATC GAC GGC AAG TCC CTG CTG CTC ATG CAG
gln glu ile asp gly lys ser leu leu leu met gln

829 CGC ACC GAT GTC CTC ACC GGC CTG TCC ATC CGC CTG
arg thr asp val leu thr gly leu ser ile arg leu

865 GGG CCA GCG TTG AAA ATC TAT GAG CAC CAT ATC AAG
gly pro ala leu lys ile tyr glu his his ile lys

901 GTG CTG CAG CAG GGT CAC TTC GAG GAC GAT GAC CCG
val leu gln gln gly his phe glu asp asp asp pro

937 GAA GGC TTC CTG GGA TGA GCA CAG AGC CGC CGC GCC
glu gly phe leu gly

973 CCT TGT CCC CAC CCC CAC CCC GCC TGG ACC CAT TCC

1009 TGC CTC CAT GTC ACC CAA GGT GTC CCA GAG GCC AGG

1045 AGC TGG ACT GGG CAG GCG AGG GGT GCG GAC CTA CCC

1081 TGA TTC TGG TAG GGG GCG GGG CCT TGC TGT GCT CAT

1117 TGC TAC CCC CCC ACC CCG TGT GTG TCT CTG CAC CTG

1153 CCC CCA GCA CAC CCC TCC CGG AGC CTG GAT GTC GCC

1189 TGG GAC TCT GGC CTG CTC ATT TTG CCC CCA GAT CAG

1225 CCC CCT CCC TCC CTC CTG TCC CAG GAC ATT TTT TAA

1261 AAG AAA AAA AGG AAA AAA AAA AAT TGG GGA GGG GGC

1297 TGG GAA GGT GCC CCA AGA TCC TCC TCG GCC CAA CCA

1333 GGT GTT TAT TCC TAT ATA TAT ATA TAT ATG TTT TGT

1369 TCT GCC TGT TTT TCG TTT TTT GGT GCG TGG CCT TTC

1405 TTC CCT CCC ACC ACC ACT CAT GGC CCC AGC CCT GCT

1441 CGC CCT GTC GGC GGG AGC AGC TGG GAA TGG GAG GAG

1477 GGT GGG ACC TTG GGT CTG TCT CCC ACC CTC TCT CCC

1513 GTT GGT TCT GTT GTC GCT CCA GCT GGC TGT ATT GCT

1549 TTT TAA TAT TGC ACC GAA GGG TTG TTT TTT TTT TTT

1585 TAA ATA AAA TTT TAA AAA AAG GAA AAA AAA AAA

1 GTG GAA AAT AGC AAC TGT GTT TCT CAA GGA TCC AAT
37 CCC AAC CTA AGG TGG CAG CGC ACA ATG AAG AAT CAA
met lys asn gln
73 GAC AAA AAG AAC GGG GCT GCC AAA CAG CCC AAC CCC
asp lys lys asn gly ala ala lys gln pro asn pro
109 AAA AGC AGC CCG GGA CAG CCG GAA GCA GGA GCG GAG
lys ser ser pro gly gln pro glu ala gly **ala** glu
145 GGA GCC CAG GGG CGG CCC GGC CGG CCG GCC CCC GCC
gly ala gln **gly** arg pro **gly** **arg** **pro** ala pro ala
181 CGA GAA GCC GAA GGT GCC AGC AGC CAG GCT CCC GGG
arg glu ala glu gly **ala** ser ser gln ala pro **gly**
217 AGG CCG GAG GGG GCT CAA GCC AAA ACT GCT CAG CCT
arg pro glu gly ala gln ala **lys** thr ala gln **pro**
253 GGG GCG CTC TGT GAT GTC TCT GAG GAG CTG AGC CGC
gly ala leu **cys** asp val ser glu glu leu ser arg
289 CAG TTG GAA GAC ATA CTC AGT ACA TAC TGT GTG GAC
gln leu glu asp ile leu ser thr tyr cys val asp
325 AAC AAC CAG GGG GCC CCG GGT GAG GAT GGG GTC CAG
asn asn gln gly **ala** pro gly glu asp gly **val** gln
361 GGT GAG CCC CCT GAA CCT GAA GAT GCA GAG AAG TCT
gly glu pro **pro** glu pro glu asp ala glu lys ser
397 CGC GCC TAT GTG GCA AGG AAT GGG GAG CCG GAG CCG
arg **ala** tyr val ala arg asn gly glu pro glu pro
433 GGC ACC CCA GTA GTC AAT GGC GAG AAG GAG ACC TCC
gly thr pro val val **asn** gly glu lys glu **thr** ser
469 AAG GCA GAG CCG GGC ACG GAA GAG ATC CGG ACG AGC
lys **ala** **glu** pro **gly** thr glu glu ile arg **thr** ser
505 GAT GAG GTC GGA GAC CGA GAC CAC CGG AGG CCA CAG
asp glu val gly asp arg asp his arg arg pro gln

541 GAA AAG AAG AAG GCC AAG GGT CTG GGA AAG GAG ATC
glu lys lys lys ala lys gly leu gly lys glu ile

577 ACG CTG CTG ATG CAG ACA CTG AAC ACG CTG AGC ACC
thr leu leu met gln thr leu asn thr leu ser thr

613 CCA GAG GAG AAG CTG GCG GCT CTG TGC AAG AAG TAT
pro glu glu lys leu ala ala leu cys lys lys tyr

649 GCG GAA CTG CTC GAG GAG CAC CGG AAC TCG CAG AAG
ala glu leu leu glu glu his arg asn ser gln lys

685 CAG ATG AAG CTG CTG CAG AAG AAG CAG AGC CAG CTG
gln met lys leu leu gln lys lys gln ser gln leu

721 GTG CAG GAG AAG GAC CAC CTG CGT GGC GAG CAC AGC
val gln glu lys asp his leu arg gly glu his ser

757 AAG GCC ATC CTG GCC CGC AGC AAG CTC GAG AGC CTG
lys ala ile leu ala arg ser lys leu glu ser leu

793 TGC CGG GAG CTG CAG CGG CAC AAC CGC TCG CTC AAG
cys arg glu leu gln arg his asn arg ser leu lys

829 GAA GAA GGT GTG CAG CGA GCC CGA GAG GAG GAG GAG
glu glu gly val gln arg ala arg glu glu glu glu

865 AAG CGC AAG GAG GTG ACG TCA CAC TTC CAG ATG ACG
lys arg lys glu val thr ser his phe gln met thr

901 CTC AAC GAC ATT CAG CTG CAG ATG GAG CAG CAC AAC
leu asn asp ile gln leu gln met glu gln his asn

937 GAG CGC AAC TCC AAG CTG CGC CAG GAG AAC ATG GAG
glu arg asn ser lys leu arg gln glu asn met glu

973 CTG GCC GAG CGG CTC AAG AAG CTG ATT GAG CAG TAC
leu ala glu arg leu lys lys leu ile glu gln tyr

1009 GAG CTG CGA GAA GAG CAC ATC GAC AAA GTC TTC AAA
glu leu arg glu glu his ile asp lys val phe lys

14/21 (continued)

1045 CAC AAG GAT CTG CAG CAG CAG CTG GTG GAC GCC AAG
his lys asp leu gln gln gln leu val asp ala lys

1081 CTC CAG CAG GCC CAG GAG ATG CTG AAG GAG GCA GAG
leu gln gln ala gln glu met leu lys glu ala glu

1117 GAG CGG CAC CAG CGG GAG AAG GAC TTT CTC CTG AAG
glu arg his gln arg glu lys asp phe leu leu lys

1153 GAG GCC GTG GAG TCC CAG AGG ATG TGC GAG CTG ATG
glu ala val glu ser gln arg met cys glu leu met

1189 AAG CAA CAG GAG ACC CAC CTG AAG CAG CAG CTT GCC
lys gln gln glu thr his leu lys gln gln leu ala

1225 CTA TAC ACA GAG AAG TTT GAG GAG TTC CAG AAC ACT
leu tyr thr glu lys phe glu glu phe gln asn thr

1261 CTT TCC AAA AGC AGC GAG GTG TTC ACC ACA TTC AAA
leu ser lys ser ser glu val phe thr thr phe lys

1297 CAG GAA ATG GAA AAG ATG ACA AAG AAG ATC AAG AAG
gln glu met glu lys met thr lys lys ile lys lys

1333 CTG GAG AAA GAG ACC ACC ATG TAC CGT TCC CGG TGG
leu glu lys glu thr thr met tyr arg ser arg trp

1369 GAG AGC AGC AAC AAG GCC CTG CTT GAG ATG GCT GAG
glu ser ser asn lys ala leu leu glu met ala glu

1405 GAG AAA ACA CTC CGG GAC AAA GAG CTG GAA GGC CTG
glu lys thr **leu** arg asp lys glu leu glu gly leu

1441 CAG GTG AAA ATC CAG CGG CTG GAG AAG CTG TGC CGG
gln val lys ile gln arg leu glu lys leu cys arg

1477 GCA CTG CAG ACA GAG CGC AAT GAC CTG AAC AAG AGG
ala leu gln thr glu arg asn asp leu asn lys arg

1513 GTG CAG GAC CTG AGT GCC GGT GGC CAG GGC CCC GTC
val gln asp leu ser ala gly gly gln gly **pro val**

14/21 (continued)

1549 TCC GAC AGC GGT CCT GAG CGG AGG CCA GAG CCC GCC
ser asp ser gly pro glu arg arg pro glu pro ala

1585 ACC ACC TCC AAG GAG CAG GGT GTC GAG GGC CCC GGG
thr thr ser lys glu gln gly val glu gly pro gly

1621 GCT CAA GTA CCC AAC TCT CCA AGG GCC ACA GAC GCT
ala gln val pro asn ser pro arg ala thr asp ala

1657 TCC TGC TGC GCA GGT GCA CCC AGC ACA GAG GCA TCA
ser cys cys ala gly ala pro ser thr glu ala ser

1693 GGC CAG ACA GGG CCC CAG GAG CCC ACC ACT GCC ACT
gly gln thr gly pro gln glu pro thr thr ala thr

1729 GCC TAG AGA GCT TGG TGC TGG GGT GTG CCA GGA AGG
ala

1765 GAG CAG GCA GCC CAG CCA GGC CTG GCC CAG CCC AGG

1801 CTC CCA TGC TAA GCA GTC CGG TGC TGA GGC CAG GAT

1837 GTT CTG ACC TGG CTG GCA CCT GAC CCT CTG CAG TCT

1873 TGG ATT TTG TGG GTC AGT TTT ACA TGC ATA TGG CAC

1909 ACA TGC AAG GCC TCA CAC ATT TGT GTC TCT AAG TGT

1945 ACT GTG GGC TTG CAT CGG GGG TGA CGA TGG ACA GAT

1981 GAA GCC AGC GGC TCC CTT GTG AGC TGA AGT CTT ACG

2017 GAG GAG ACG GCG TCT GCA CTG CCA TCG CAG TGA CCT

2053 GCA GGA CGA GTT CCT TGA GCT TTC CCT GCC TGC TTT

2089 GAG GCT GAG ACC CCT CCC GGC CCT TCA GAG CTC CTG

2125 ACA GGT GAT ACA CAC CCA GCC TTG ACC GCA CTT CTC

2161 TTG GGT AGC TGG GCT CTC CTA GCC TCC CCC AGA GGC

2197 GCC ATT GCT TCT CTT GAC TTG GAG AGG GGA TGC CCA

2233 GGC GTG GCC TTG GCA GGC ACT GGG AGC TAG TGA TTG

2269 GGC TGC TCT CCT GCC TCG AGC AGG GGC AGG AGT GTT

2305 TCT GGT GGG ATG ATG CGC TCG CTG GTC AGG AGC CCC

2341 GTG GGC GCT GCT TCC CCC GCC CTC TGG TGA TGC CAG

2377 GAC CAG GCC AGT GAT GCT TCT CAG TAG CCT TAC CAT

2413 TCA CAG GTG CCT CTC CAG CCC GCA CAG TGA GTG ACA

2449 AGA TCA TCC AAA GGA TTC CTT CTG AAG GTG TTC GTT

2485 TCG TTT TGT TTT GTT GCA CGT GAC GGT TTG TAT TGA

2521 GGA CCC TCT GAG GAA GAG GGG TGC TGT AGC AGT GGT

2557 CCC TGC GTG CCT GGC TCC AGT GTC CTG CCC TCC CCC

2593 CCC TCG CCA TGG CTC CTC GGC CGC CTT GGT GCT GAG

2629 GTT TCT GTT TGG TGA GAT CAG GTT GTC TGT TCA GAG

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2665	AGA	AGA	GGC	GTC	TGA	TGG	CTT	TGC	CGC	CAG	CTT	GCC
2701	TGC	GGG	CCT	CAA	TCC	CGG	GAG	GCC	GCC	CGG	TTC	CCG
2737	TCA	CTG	TTG	TCC	CCG	TGC	AGT	GCG	TTG	CTG	GTC	CCC
2773	AGG	ACC	AGC	TGC	TCG	TTT	GCT	GTA	TGG	GTC	AGT	TTC
2809	TGC	TTC	CTG	CCC	CCC	ACT	CCA	CCT	AAC	TGC	AAT	CCT
2845	TGG	GGT	TTC	CCT	GGT	TCT	CGT	CCC	TGG	TAC	CTC	TGT
2881	GCC	CAA	GAA	GTA	GCC	TTC	TTT	GGG	ATT	CTT	GTT	CTG
2917	CCC	ATG	CGG	GAG	CTG	CTG	CTG	TCT	GAC	AGG	TGA	GGC
2953	CTG	AGA	CTC	AGC	GGC	TGA	CAG	AGC	TGC	AGA	GCT	CTG
2989	CAC	GGT	GGC	TCC	CGG	GGC	GGC	CTC	TGT	GTG	CTG	CAC
3025	ACC	GCT	GCT	CTG	CTG	GCA	CTG	GCC	AGT	CTG	TGC	AGA
3061	GCA	TTT	GAG	TAC	TGG	CTC	AGG	AGG	GAG	GGC	TCT	GCT
3097	GGC	CTC	GAG	GGA	CAG	CGC	CAC	GTC	TCC	AGC	TGG	GCT
3133	CAG	GGA	GAG	CCC	CAG	ACT	GGC	TGC	GTA	GGG	TGC	TTG
3169	GGG	TTT	GCT	TCT	TGC	AGT	ATT	TCT	TGG	AAG	CTG	TTT
3205	TGT	TGT	CCT	GCT	ATT	CCT	TCA	TCT	TCC	ACA	GTC	CAC
3241	GCT	CAG	CCT	TTA	ACT	TGG	ATC	CCT	CAC	ATA	ACA	GGG
3277	TTC	ATG	AGA	CCC	GCA	AGT	ACG	CCC	AAG	CTA	CGT	ATG
3313	GCT	GAG	GCC	AGC	TGG	CAG	GTG	AAT	GGC	ACG	CCA	TTG
3349	CTG	CTG	CTA	ATC	CCT	GGC	ATA	TCT	TTA	GTT	CAC	CTC
3385	GAA	ATG	CCC	CCG	CCA	CAG	TGC	AAG	CAG	TGA	GTC	CAC
3421	GTG	CCA	CCC	TGG	GCT	GAA	TCC	CAC	CCC	CTG	TGA	GTG
3457	TTG	CCC	GAG	ATT	GTG	TCT	CTT	CTG	AAT	GCC	TTC	ACT
3493	GGG	AAT	GGC	CTC	TGC	CGC	CTC	CTG	CTC	AGG	GAG	GCT
3529	TTC	CCC	TTC	CCT	CAG	CCC	CTG	TGC	CAG	ACT	GAG	GTA
3565	CAA	GAA	CCG	CCA	AGC	CCA	TGC	AAG	GTG	TGG	CTA	GGC
3601	GCC	AGG	GTG	CAG	GAA	GGA	GGC	AGG	TAG	CTG	CCT	GCA
3637	CCC	TTG	AAA	GCC	AAG	AGG	CCT	ACG	GTG	GCC	TCC	ATC
3673	CTG	GCT	TGC	CTC	ACT	TCA	GCT	ACC	TCG	CAT	AGC	CCA
3709	GGG	GTG	GGG	CTA	TTG	GAT	TCC	AGG	GTG	GGG	GGA	TGG
3745	GAA	GCT	GCA	GGG	GGC	AGG	TGG	CTC	TCA	CTA	GGC	TTC
3781	CCA	GCT	CAG	GAA	TGT	GGG	CCT	CAG	GTA	GGG	GAG	AGC
3817	CTT	TGC	TCC	ACT	CCA	CCC	ATT	TGC	AGG	CAT	CTA	GGC
3853	CAG	TCT	AGA	TGG	CGA	CCC	CTT	CTC	TTC	CTC	TCC	ATT
3889	GAC	CAA	ATC	GTA	CCT	GTC	TCT	CCA	GCT	GCT	CGC	TTG
3925	CTC	TGC	TTT	CCA	AAG	TCA	GCC	CAG	GTA	CCC	AGG	TGC
3961	CGC	CCA	CAT	TGG	CCT	GGA	ACC	TGG	ACC	AGA	GGC	AAG
3997	GGA	GGT	GGC	CTA	TCC	TTG	AGT	GAT	AGC	CAG	TGC	CTT
4033	CCT	CAC	CCG	GTG	GCT	TCC	ATG	CCT	GTG	ACC	TCA	GAT
4069	TTA	GGA	CCA	AGA	GCT	GTG	TTG	GTT	TCT	TAC	GTT	GTG
4105	AGC	TTT	CCC	TCC	AGG	GGA	CCA	CAG	CAG	GTG	AGG	CTC
4141	GGA	GCC	CAG	AGC	CCT	TGG	CGC	CGC	CAG	CAG	TAA	CTT
4177	GTG	TCC	GGA	CCT	TGT	CCA	GCT	GAG	CGC	TTC	GTG	TAT

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4213 GAC TCA GCT TCG TGT GTG AGT CCA GCG GAG TGC GTC
4249 ACG TGA CCT AGA CTC AGC GGT GTC AGC CGC ACT TTG
4285 ATT TGT TTG TTT TCC ATG AGG TTT TTG GAC CAT GGG
4321 CTT AGC TCA GGC AAC TTT TCT GTA AGG AGA ATG TTA
4357 ACT TTC TGT AAA GAT GCT TAT TTA ACT AAC GCC TGC
4393 TTC CCC CAC TCC CAA CCA GGT GGC CAC CGA GAG CTC
4429 ACC AGG AGG CCA ATA GAG CTG CTC CAG CTC TCC CAT
4465 CTT GCA CCG CAC AAA GGT GGC CGC CCC AGG GAC AGC
4501 CAG GCA CCT GCC TGG GGG AGG GGC TTC TCT TCC TTA
4537 TGG CCT GGC CAT CTA GAT TGT TTA AAG TTG TGC TGA
4573 CAG CTT TTT TTG GTT TTT TGG TTT TTG TTT TTG TTT
4609 TTG TTT TTG TTT TTG TCT ACT TTT GGT ATT CAC AAC
4645 AGC CAG GGA CTT GAT TTT GAT GTA TTT TAA GCC ACA
4681 TTA AAT AAA GAG TCT GTT GCC TTA AAA AAA AAA AAA
4717 AAA AAA

1 GAC GCC TCA GAG CGG AAC AGG GAA GTG AAT CAG GCG
37 CCG GGT AGT GGG TTG CTG GGC TGG GCT TGC TGA GGT
73 AGA GGC AGC GCC AAG AAG AGG CCT TTG CCG CTG GTC
109 GGG ATT GGG ATG TCG AAG AAC ACA GTG TCG TCG GCC
met ser lys asn thr val ser ser ala

145 CGC TTC CGG AAG GTG GAC GTG GAT GAA TAT GAC GAG
arg phe arg lys val asp val asp glu tyr asp glu

181 AAC AAG TTC GTG GAC GAA GAA GAT GGG GGC GAC GGC
asn lys phe val asp glu glu asp gly gly asp gly

217 CAG GCC GGG CCC GAC GAG GGC GAG GTG GAC TCC TGC
gln ala gly pro asp glu gly glu val asp ser cys

253 CTG CGG CAA GGA AAC ATG ACA GCT GCC CTA CAG GCA
leu arg gln gly asn met thr ala ala leu gln ala

289 GCT CTG AAG AAC CCC CCT ATC AAC ACC AAG AGT CAG
ala leu lys asn pro pro ile asn thr **lys** ser gln

325 GCA GTG AAG GAC CGG GCA GGC AGC ATT GTC TTG AAG
ala val lys asp arg ala gly ser ile val leu lys

361 GTG CTC ATC TCT TTT AAA GCT AAT GAT ATA GAA AAG
val leu ile ser phe lys ala **asn** asp ile glu lys

397 GCA GTT CAA TCT CTG GAC AAG AAT GGT GTG GAT CTC
ala val gln ser leu asp **lys** asn gly val asp leu

433 CTA ATG AAG TAT ATT TAT AAA GGA TTT GAG AGC CCG
leu met lys tyr ile tyr lys gly phe glu ser pro

469 TCT GAC AAT AGC AGT GCT ATG TTA CTG CAA TGG CAT
ser asp **asn** ser ser ala **met** leu leu gln trp his

505 GAA AAG GCA CTT GCT GCT GGA GGA GTA GGG TCC ATT
glu lys ala leu ala ala gly gly val gly ser ile

541 GTT CGT GTC TTG ACT GCA AGA AAA ACT GTG TAG TCT
val arg val leu thr ala arg lys thr val

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577 GGC AGG AAG TGG ATT ATC TGC CTC GGG AGT GGG AAT
613 TGC TGG TAC AAA GAC CAA AAC AAC CAA ATG CCA CCG
649 CTG CCC TGT GGG TAG CAT CTG TTT CTC TCA GCT TTG
685 CCT TCT TGC TTT TTC ATA TCT GTA AAG AAA AAA ATT
721 ACA TAT CAG TTG TCC CTT TAA TGA AAA TTG GGA TAA
757 TAT AGA AGA AAT TGT GTT AAA ATA GAA GTG TTT CAT
793 CCT TTC AAA ACC ATT TCA GTG ATG TTT ATA CCA ATC
829 TGT ATA TAG TAT AAT TTA CAT TCA AGT TTT AAT TGT
865 GCA ACT TTT AAC CCT GTT GGC TGG TTT TTG GTT CTG
901 TTT GGT TTT GTA TTA TTT TTA ACT AAT ACT GAA AAA
937 TTT GGT CAG AAT TTG AGG CCA GTT TCC TAG CTC ATT
973 GCT AGT CAG GAA ATG ATA TTT ATA AAA AAT ATG AGA
1009 GAC TGG CAG CTA TTA ACA TTG CAA AAC TGG ACC ATA
1045 TTT CCC TTA TTT AAT AAG CAA AAT ATG TTT TTG GAA
1081 TAA GTG GTG GGT GAA TAC CAC TGC TAA GTT ATA GCT
1117 TTG TTT TTG CTT GCC TCC TCA TTA TCT GTA CTG TGG
1153 GTT TAA GTA TGC TAC TTT CTC TCA GCA TCC AAT AAT
1189 CAT GGC CCC TCA ATT TAT TTG TGG TCA CGC AGG GTT
1225 CAG AGC AAG AAG TCT TGC TTT ATA CAA ATG TAT CCA
1261 TAA AAT ATC AGA GCT TGT TGG GCA TGA ACA TCA AAC
1297 TTT TGT TCC ACT AAT ATG GCT CTG TTT GGA AAA AAC
1333 TGC AAA TCA GAA AGA ATG ATT TGC AGA AAG AAA GAA
1369 AAA CTA TGG TGT AAT TTA AAC TCT GGG CAG CCT CTG
1405 AAT GAA ATG CTA CTT TCT TTA GAA ATA TAA TAG CTG
1441 CCT TAG ACA TTA TGA GGT ATA CAA CTA GTA TTT AAG
1477 ATA CCA TTT AAT ATG CCC CGT AAA TGT CTT CAG TGT
1513 TCT TCA GGG TAG TTG GGA TCT CAA AAG ATT TGG TTC
1549 AGA TCC AAA CAA ATA CAC ATT CTG TGT TTT AGC TCA
1585 GTG TTT TCT AAA AAA AGA AAC TGC CAC ACA GCA AAA
1621 AAT TGT TTA CTT TGT TGG ACA AAC CAA ATC AGT TCT
1657 CAA AAA ATG ACC GGT GCT TAT AAA AAG TTA TAA ATA
1693 TCG AGT AGC TCT AAA ACA AAC CAC CTG ACC AAG AGG
1729 GAA GTG AGC TTG TGC TTA GTA TTT ACA TTG GAT GCC
1765 AGT TTT GTA ATC ACT GAC TTA TGT GCA AAC TGG TGC
1801 AGA AAT TCT ATA AAC TCT TTG CTG TTT TTG ATA CCT
1837 GCT TTT TGT TTC ATT TTG TTT TGT TTT GTA AAA ATG
1873 ATA AAA CTT CAG AAA ATA AAA TGT CAG TGT TGA ATA
1909 ATT AAA AAA AAA AAA AA

1 GAA GAG CGA GTA CTT GAG AAA GAA GAG GAA GAA GAT
glu glu arg val leu glu lys glu glu glu glu **asp**

37 GAT GAT GAA GAT GAA GAT GAA GAA GAT GAT GTG TCA
asp asp glu asp **glu asp glu glu** asp asp val ser

73 GAG GGC TCT GAA GTG CCC GAG AGT GAC CGT CCT GCA
glu gly ser glu val pro glu ser asp arg pro ala

109 GGT GCC CAG CAC CAC CAG CTT AAC GGC GAG CGG GGA
gly ala gln his his gln leu asn gly glu arg gly

145 CCT CAG AGT GCC AAG GAG AGG GTC AAG GAG TGG ACC
pro gln **ser** ala lys glu arg **val** lys glu trp **thr**

181 CCC TGC GGA CCG CAC CAG GGC CAG GAT GAA GGG CGG
pro cys gly pro his **gln** gly gln **asp** glu gly arg

217 GGG CCA GCC CCG GGC AGC GGC ACC CGC CAG GTG TTC
gly pro ala **pro** gly ser gly thr arg gln val phe

253 TCC ATG GCA GCC ATG AAC AAG GAA GGG GGA ACA GCT
ser met ala ala **met asn** lys glu gly gly **thr** ala

289 TCT GTT GCC ACC GGG CCA GAC TCC CCG TCC CCC GTG
ser **val ala** thr gly pro asp ser pro ser pro val

325 CCT TTG CCC CCA GGC AAA CCA GCC CTA CCT GGG GCC
pro leu pro pro gly lys pro ala leu pro gly ala

361 GAC GGG ACC CCC TTT GGC TGT CCT CCC GGG CGC AAA
asp gly thr pro phe gly cys pro **pro** gly arg lys

397 GAG AAG CCA TCT GAT CCC GTC GAG TGG ACC GTG ATG
glu lys pro **ser** asp pro val glu trp thr val met

433 GAT GTC GTC GAA TAT TTT ACT GAG GCT GGA TTC CCG
asp val val glu tyr phe thr glu ala gly phe pro

469 GAG CAG GCG ACA GCT TTC CAA GAG CAG GAA ATT GAT
glu gln ala thr ala phe gln glu gln glu ile asp

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505 GGC AAA TCT TTG CTG CTC ATG CAG CGC ACA GAT GTG
gly lys ser leu leu leu met gln arg thr asp val

541 CTC ACC GGC CTG TCC ATC CGC CTC GGG CCA GCC CTG
leu thr gly leu ser ile arg leu gly pro ala leu

577 AAA ATC TAC GAG CAC CAC ATC AAG GTG CTT CAG CAA
lys ile tyr glu his his ile lys val leu gln gln

613 GGC CAC TTT GAG GAT GAT GAC CCC GAT GGC TTC TTA
gly his phe glu asp asp asp pro **asp** gly phe leu

649 GGC TGA GCG CCC AGC CTC ACC CCT GCC CCA GCC CAT
gly

685 TCC GGC CCC CAT CTC ACC CAA GAT CCC CCA GAG TCC

721 AGG AGC TGG ACG GGG ACA CCC TCA GCC CTC ATA ACA

757 GAT TCC AAG GAG AGG GCA CCC TCT TGT CCT TAT CTT

793 TGC CCC TTG TNT CTG TCT CAC ACA CAT CTG CTC CTC

829 AGC ACG TCG GTG TGG GGA GGG GAT TGC TCC TTA AAC

865 CCC AGG TGG CTG ACC CTC CCC ACC CAG TCC AGG ACA

901 TTT TAG GAA AAA AAA AAT GAA ATG TGG GGG GCT TCT

937 CAT CTC CCC AAG ATC CTC TTC CGT TCA GCC AGA TGT

973 TTC CTG TAT AAA TGT TTG GAT CTG CCT GTT TAT TTT

1009 GGT GGG TGG TCT TTC CTC CCT CCC CTA CCA CCC ATG

1045 CCC CCC TTC TCA GTC TGC CCC TGG CCT CCA GCC CCT

1081 AGG GGA CTA GCT GGG TTG GGG TTC CTC GGG CCT TTT

1117 CTC TCC TCC CTC TTT TCT TTC TGT TGA TTG TCG CTC

1153 CAG CTG GCT GTA TTG CTT TTT AAT ATT GCA CCG AAG

1189 GTT TTT TAA ATA AAA TTT TA

1 CA AAA AGC AGC CCA GGA CAA CCG GAA GCA GGA CCC GAG GGA GCC
lys ser ser pro gly gln pro glu ala gly pro glu gly ala

45 CAG GAG CGG CCC AGC CAG GCG GCT CCT GCA GTA GAA GCA GAA GGT
gln glu arg pro ser gln ala ala pro ala val glu ala glu gly

90 CCC GGC AGC AGC CAG GCT CCT CGG AAG CCG GAG GGG GCT CAA GCC
pro gly ser ser gln ala pro arg lys pro glu gly ala gln ala

135 AGA ACG GCT CAG TCT GGG GCC CTT CGT GAT GTC TCT GAG GAG CTG
arg thr ala gln ser gly ala leu arg asp val ser glu glu leu

180 AGC CGC CAA CTG GAA GAC ATA CTG AGC ACA TAC TGT GTG GAC AAT
ser arg gln leu glu asp ile leu ser thr tyr cys val asp asn

225 AAC CAG GGG GGC CCC GGC GAG GAT GGG GCA CAG GGT GAG CCG GCT
asn gln gly gly pro gly glu asp gly ala gln gly glu pro ala

270 GAA CCC GAA GAT GCA GAG AAG TCC CGG ACC TAT GTG GCA AGG AAT
glu pro glu asp ala glu lys ser arg thr tyr val ala arg asn

315 GGG GAG CCT GAA CCA ACT CCA GTA GTC TAT GGA GAG AAG GAA CCC
gly glu pro glu pro thr pro val val tyr gly glu lys glu pro

360 TCC AAG GGG GAT CCA AAC ACA GAA GAG ATC CGG CAG AGT GAC GAG
ser lys gly asp pro asn thr glu glu ile arg gln ser asp glu

405 GTC GGA GAC CGA GAC CAT CGA AGG CCA CAG GAG AAG AAA AAA GCC
val gly asp arg asp his arg arg pro gln glu lys lys lys ala

450 AAG GGT TTG GGG AAG GAG ATC ACG TTG CTG ATG CAG ACA TTG AAT
lys gly leu gly lys glu ile thr leu leu met gln thr leu asn

495 ACT CTG AGT ACC CCA GAG GAG AAG CTG GCT GCT CTG TGC AAG AAG
thr leu ser thr pro glu glu lys leu ala ala leu cys lys lys

540 TAT GCT GAA CTG CTG GAG GAG CAC CGG AAT TCA CAG AAG CAG ATG
tyr ala glu leu leu glu glu his arg asn ser gln lys gln met

585 AAG CTC CTA CAG AAA AAG CAG AGC CAG CTG GTG CAA GAG AAG GAC
lys leu leu gln lys lys gln ser gln leu val gln glu lys asp

630 CAC CTG CGC GGT GAG CAC AGC AAG GCC GTC CTG GCC CGC AGC AAG
his leu arg gly glu his ser lys ala val leu ala arg ser lys

675 CTT GAG AGC CTA TGC CGT GAG CTG CAG CGG CAC AAC CGC TCC CTC
leu glu ser leu cys arg glu leu gln arg his asn arg ser leu

17/21 (continued)

720 AAG GAA GAA GGT GTG CAG CGG GCC CGG GAG GAG GAG GAG AAG CGC
lys glu glu gly val gln arg ala arg glu glu glu glu lys arg

765 AAG GAG GTG ACC TCG CAC TTC CAG GTG ACA CTG AAT GAC ATT CAG
lys glu val thr ser his phe gln val thr leu asn asp ile gln

810 CTG CAG ATG GAA CAG CAC AAT GAG CGC AAC TCC AAG CTG CGC CAA
leu gln met glu gln his asn glu arg asn ser lys leu arg gln

855 GAG AAC ATG GAG CTG GCT GAG AGG CTC AAG AAG CTG ATT GAG CAG
glu asn met glu leu ala glu arg leu lys lys leu ile glu gln

900 TAT GAG CTG CGC GAG GAG CAT ATC GAC AAA GTC TTC AAA CAC AAG
tyr glu leu arg glu glu his ile asp lys val phe lys his lys

945 GAC CTA CAA CAG CAG CTG GTG GAT GCC AAG CTC CAG CAG GCC CAG
asp leu gln gln gln leu val asp ala lys leu gln gln ala gln

990 GAG ATG CTA AAG GAG GCA GAA GAG CGG CAC CAG CGG GAG AAG GAT
glu met leu lys glu ala glu glu arg his gln arg glu lys asp

1035 TTT CTC CTG AAA GAG GCA GTA GAG TCC CAG AGG ATG TGT GAG CTG
phe leu leu lys glu ala val glu ser gln arg met cys glu leu

1080 ATG AAG CAG CAA GAG ACC CAC CTG AAG CAA CAG CTT GCC CTA TAC
met lys gln gln glu thr his leu lys gln gln leu ala leu tyr

1125 ACA GAG AAG TTT GAG GAG TTC CAG AAC ACA CTT TCC AAA AGC AGC
thr glu lys phe glu glu phe gln asn thr leu ser lys ser ser

1170 GAG GTA TTC ACC ACA TTC AAG CAG GAG ATG GAA AAG ATG ACT AAG
glu val phe thr thr phe lys gln glu met glu lys met thr lys

1215 AAG ATC AAG AAG CTG GAG AAA GAA ACC ACC ATG TAC CGG TCC CGG
lys ile lys lys leu glu lys glu thr thr met tyr arg ser arg

1260 TGG GAG AGC AGC AAC AAG GCC CTG CTT GAG ATG GCT GAG GAG AAA
trp glu ser ser asn lys ala leu leu glu met ala glu glu lys

1305 ACA GTC CGG GAT AAA GAA CTG GAG GGC CTG CAG GTA AAA ATC CAA
thr val arg asp lys glu leu glu gly leu gln val lys ile gln

1350 CGG CTG GAG AAG CTG TGC CGG GCA CTG CAG ACA GAG CGC AAT GAC
arg leu glu lys leu cys arg ala leu gln thr glu arg asn asp

1395 CTG AAC AAG AGG GTA CAG GAC CTG AGT GCT GGT GGC CAG GGC TCC
leu asn lys arg val gln asp leu ser ala gly gly gln gly ser

1440 CTC ACT GAC AGT GGC CCT GAG AGG AGG CCA GAG GGG CCT GGG GCT
leu thr asp ser gly pro glu arg arg pro glu gly pro gly ala

17/21 (continued)

1485 CAA GCA CCC AGC TCC CCC AGG GTC ACA GAA GCG CCT TGC TAC CCA
gln ala pro ser ser pro arg val thr glu ala pro cys tyr pro

1530 GGA GCA CCG AGC ACA GAA GCA TCA GGC CAG ACT GGG CCT CAA GAG
gly ala pro ser thr glu ala ser gly gln thr gly pro gln glu

1575 CCC ACC TCC GCC AGG GCC TAG AGA GCC TGG TGT TGG GTC ATG CTG
pro thr ser ala arg ala ***

1620 GGA AGG GAG CGG CAG CCC AGC CAG GCC TGG CCC ATA AAA GGC TCC
1665 CAT GCT GAG CAG CCC ATT GCT GAA GCC AGG ATG TTC TTG ACC TGG
1710 CTG GCA TCT GGC ACT TGC AAT TTT GGA TTT TGT GGG TCA GTT TTA
1755 CGT ACA TAG GGC ATT TTG CAA GGC CTT GCA AAT GCA TTT ATA CCT
1800 GTA AGT GTA CAG TGG GCT TGC ATT GGG GAT GGG GGT GTG TAC AGA
1845 TGA AGT CAG TGG CTT GTC TGT GAG CTG AAG AGT CTT GAG AGG GGC
1890 TGT CAT CTG TAG CTG CCA TCA CAG TGA GTT GGC AGA AGT GAC TTG
1935 AGC ATT TCT CTG TCT GAT TTG AGG CTC AGA CCC CTC CCT GCC CTT
1980 TCA GAG CTC AAA ACA AGT AAT ACA CCA AGG TCT TGA CTG CAT TTG
2025 TCT TGT GAG CAG GGC TTG CTT GGT CAG CTC AGG CCC TCC TAG CTG
2070 CTT GGA GGC TCC TTT GAT TCT CTA GAC CTG GAA AAG GTG TCC CTA
2115 GGC AGA GCC CTG GCA GGG CGC TCA GAG CTG GGA TTT CCT GCC TGG
2160 AAC AAG GGA CCT GGA GAA TGT TTT TGC GTG GGA TGA TGT GCT GGT
2205 CAG GAG CCC CTT GGG CAT CGC TTC CCC TGC CCT TTG GTA GTG CCA
2250 GGA CCA GGC CAA TGA TGC TTC TCA GTA GCC TTA TCA TTC ACA GGT
2295 GCC TCT CTA GCC TGC ACA AAT GAT TGA CAA GAG ATC ACC CAA AGG
2340 ATT ATT TCT GAA GGT GTT TTT TTC TTT ATT TCT TTT TCT TTT TTT
2385 TTT TTT CTT TTT CTT TTT TTT TTG CAC ATG ACA GTG TTT GTA TTG
2430 AGG ACC TTC CAA GGA AAA GGG ATG CTG TAC CAG TGG TGC CTG GGT
2475 GCC TGG CCT CCA GTG TCC CAC CTC CTT CAC CAC CCC ACT TGG CTC
2520 CTT TGC CAT CTT GAT GCT GAG GTT TCC TGT TTG GTG AGA TCA GGT
2565 TGT TTG TGG TAA AAG AAA GGA AAG GGC TTC TGA TGG CTT TGC CAC
2610 AAG CTT ACC TGT GGG TTT CAG TCC TGA GAG GCC ACC ACC AGT TCC
2655 CAT CAG CAC TGT CTC CAT GCA GCA GTT GCT GGG TCC CAT GTC CAG
2700 CTG CCT CTT TGG CTT CAT GGG TTT TTC TGC TTC CTG CCC CCA CCC
2745 CCA CAT GTG CAA TCC TCA AGA TTT GTC CTG ATT CTA TTT CCT GGC
2790 ACC TCC CTG CCT GTC CTT GGG GAT TCT ACT TCT TCC TGT GTG GGG
2835 CCC ATA GCT GTT GTC TAA CAG GTA AGA AAT GAA ATT GAA CTA TTG
2880 ACT GGG CCC CAG AAA TCC ATA AAA TGG CTG CAG ACA GTT GTT TCT
2925 GTG TCC TGT TCT ACC CCC ACT CCA GTA CAT AAC TAC TAT GTA CTG
2970 TGT AGA GCC ATT CTA TAT GCT GAA TGT TCT GCT GTT GCA AAC TTG
3015 CCA GGG TAT TAG CCA GTG TTT GTG CCA AGC AGT TTT CGG GGA CAA
3060 CAG AAT GAC TCA GAC CAA GAT GGA TAG GAT GGT TAG GGC TTT GCT
3105 TCT TGC TGT TTT TCT TTG AAC TAG TCA TTG TCC TGC AGG TCC CTT
3150 CAT CTT CCA TAC CTA GCC CAC TCT TTT AGC CCT TAC CTT AAA TCT
3195 CTC AGA TAA GTT GGT TCA CAA AGA ATG TTA AGT ACT GAA TCA TGT
3240 GTG ACT GAG ACC AGA GAT GGC AAA TGA ATG GCA CAC CAT TTC TCC
3285 TTC TCC TGC CCC AGG GCA GGT ACC ACT GAT CTG CAT CAG AGT TGC
3330 CTG CTA TTC TCT GGT GTA TCC TTC ACA TCT AGG TGC CCT CAA GCA
3375 GCT GTG TGA GTG TTG AGA TCT CTG CCA TCT CTG GCT GAG ATA CTG
3420 CTG TCC TGT GAA GTG TTT CCC ATG ACC TTT TTC TTC CCC TTT GAA
3465 TCC CTC TTG TCT GGA GTA GTC CTT GCC TTC TTC TTG CTC CAG TAG

17/21 (continued)

3510 GCC TTT TCC TTA CCC CAG CCC TTG TGC CAG GCT AAG CTG GTA CAA
3555 GAG CTG CCA ACT CAC AGA GTT TTG CTA GGC GAG AGA GGT GCA GGG
3600 AAG AGG CAG AGG TAT GCA CCT TCC CCC TTG AAG AGA GGG GAA AGG
3645 CCT ACA GTG GCC CAC ATA ATT GCC TGA CTC ACA CTT CAG CTA CCT
3690 CTT AAT GCC TGT GGA GGG ACT GGA GCT GCT GGA TCC CAG TGT GGT
3735 GGT GTA GGA GGC CAC AGT GAG CAG GTG GCC CCA GCT GGG TTT CCC
3780 AGG TCA GGA ATG TGG GCC CCA GGC AAG GTG CAG CCT TTG CTC ACA
3825 GCT CCA TCC ATG TCT AGA CCT TCA GGC CAG TCT GCA GAT GAG GTT
3870 CCC TAC CTT TTT CTT CTC TTC ATT GAC CAA ATC AAC CAA TCA CTA
3915 CAG CTG CTC TGC TTC TGC TTT CCA AAG TAG CCC AGG TCC TGG GCC
3960 AGA TGC AGG GGA GGT GCC TAT CCA TGA GTG AAG GCC AGT GTC TTC
4005 CTC ACC TGG GTG GTC CCA CAC TTG TGA CCC TCA GTT TTA GGA CCC
4050 AAG ATC TGT GTT GGT TTC TTA GAT TGC TAG CTT TTC CTC CAG GGG
4095 ACC ACA GCA GGT GAA GCT CAA GAG CGC ATG GCT CTG CTA ATA GTA
4140 AAT TGT TTT CAG GGC CTT GTC CAG CTG AGA GCT TCA TGT CCA CCA
4185 GAT TCT GAG AGG TGT CAG CAG CAC TTT TTT TTT TTA TTT GTT GTT
4230 TGT TTT CCA TGA GGT TAT CGG ACC ATG GGC TGA GCT CAG GCA CTT
4275 TCT GTA GGA GAC TGT TAT TTC TGT AAA GAT GGT TAT TTA ACC CTC
4320 CTC CAC CCC ATC ACG GTG GCC CTG AGG GCT GAC CCG GAG GCC AGT
4365 GGA GCT GCC TGG TGT CCA CGG GGG AGG GCC AAG GCC TGC TGA GCT
4410 GAT TCT CCA GCT GCT GCC CCA GCC TTT CCG CCT TGC ACA GCA CAG
4455 AGG TGG TCA CCC CAG GGA CAG CCA GGC ACC TGC TCC TCT TGC CCT
4500 TCC TGG GGG AAA GGA GCT GCC TTC TGT CCC TGT AAC TGC TTT CCT
4545 TAT GGC CCA ACC CGG CCA CTC AGA CTT GTT TGA AGC TGC ACT GGC
4590 AGC TTT TTT GTC TCC TTT GGG TAT TCA CAA CAG CCA GGG ACT TGA
4635 TTT TGA TGT ATT TTA AAC CAC ATT AAA TAA AGA GTC TGT TGC CTT
4680 AAA AAA AAA AAA AAA AAA

GTG GAC GTG GAT GAG TAC GAC GAG AAC AAG TTC GTG
val asp val asp glu tyr asp glu asn lys phe val

GAC GAG GAA GAC GGC GGC GAC GGC
asp glu glu asp gly gly asp gly

	1		50
Rabbit	MSKNTVSSAR FRKVDVDEYD ENKFDVEEDG GDGQAGPDEG EVDSCLRQGN		
Human	.....	
	51		100
Rabbit	MTAALQAALK NPPINTRSQA VKDRAGSIVL KVLISFKAGD IEKAVQSLDR		
Human	.....K... ..N. ....K		
	101		150
Rabbit	NGVDLLMKYI YKGFESPSDN SSAVLLQWHE KALAAGGVGS IVRVLTARKT		
Human	.....M.....		
	151		
Rabbit	V		
Human	.		

	1					50
Rabbit	EERVLEKEEEE	EEEEEDDEDD	DDDVVSEGSE	VPESDRPAGA	QHHQLNGGER	
Human	.....	.DDD..EDEE	..--.....	.....	.....	....
	51					100
Rabbit	GPQTAKERAK	EWSLCGPHPG	QEEGRGPAAG	SGTRQVFSMA	ALSKEGGSAS	
Human	...S....V.	..TP....Q.	.D.....P.	.....	.MN....T..	
	101					150
Rabbit	STTGPDSPSP	VPLPPGKPAL	PGADGTPFGC	PAGRKEKPAD	PVEWTVMDVV	
Human	VA.....	.....	.....	.P.....S.	.....
	151					200
Rabbit	EYFTEAGFPE	QATAFQEQEI	DGKSLLLMQR	TDVLTGLSIR	LGPALKIYEH	
Human	.....	.....	.....	.....	.....
	201		220			
Rabbit	HIKVLQQGHF	EDDDPEGFLG				
Human	.....	.....D....				

	1		50
Rabbit	MKNQDKKNGA AKQPNPKSSP GQPEAGAEGA QGRPGRPAPA REAEG-ASSQ		
Human	-----	.....P... .E..SQA... V....PG...	
	51		100
Rabbit	APGRPEGAQA KTAQPGALCD VSEELSRQLE DILSTYCVDN NQGAPGEDGV		
Human	..RK..... R...S...R.	.....G.....A	
	101		150
Rabbit	QGEPPEPEDA EKSRAYVARN GEPEPGTPVV NGEKETSKE PGTEEIRTS		
Human	....A..... .T..... -..... Y....P..GD .N.....Q..		
	151		200
Rabbit	EVGDRDHRRP QEKKKAKGLG KEITLLMQL NTLSTPEEKL AALCKKYAEL		
Human	.....	
	201		250
Rabbit	LEEHRNSQKQ MKLLQKKQSQ LVQEKDHLRG EHSKAILARS KLESLCRELQ		
Human	.....	.....V.....	
	251		300
Rabbit	RHNRSLKEEG VQRAREEEEEK RKEVTSHFQM TLNDIQLQME QHNERNSKLR		
Human	.....	.....V.....	
	301		350
Rabbit	QENMELAERL KKLIEQYELR EEHIDKVFKH KDLQQQLVDA KLQQAQEMLK		
Human	.....	
	351		400
Rabbit	EAEERHQREK DFLLEKEAVES QRMCELMKQQ ETHLKQQLAL YTEKFEEFQN		
Human	.....	
	401		450
Rabbit	TLKSSEVFT TFKQEMEKMT KRIKKLEKET TMYRSRWESS NKALLEMAEE		
Human	.....	
	451		500
Rabbit	KTLRDKELEG LQVKIQRLK LCRALQTERN DLNKRVDLS AGGQGPVSDS		
Human	..V.....	.....SLT..	
	501		550
Rabbit	GPERRPEPAT TSKEQGVGEP GAQVPNSPRA TDASCCAGAP STEASGQTGP		
Human	.....	...A.S...V .E.P.YP...	
	551		
Rabbit	QEPTTATA		
Human	....S.R.		

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US97/21857

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) : Please See Extra Sheet.

US CL : Please See Extra Sheet.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 424/1.69, 9.1, 9.2, 9.34, 184.1; 435/6, 7.8, 29, 69.1, 252.33, 320.1; 436/501; 514/2, 12-19, 44, 824; 530/324-330, 350; 536/23.5

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

Please See Extra Sheet.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A,P	US 5,665,872 A (SAITO ET AL.) 09 September 1997. See column 1, line 1-column 2, line 64.	1-109
A	US 5,196,324 A (BUMOL ET AL.) 23 March 1993. See column 1, line 1-column 2, line 30.	1-109
A	DE RIJKE ET AL, "Rat liver kupfer and endothelial cells express different binding proteins for modified low density lipoproteins", The Journal of Biological Chemistry, 14 January 1994, Volume 269, Number 2, pages 824-827. See page 824, columns 1-2.	1-109

☒ Further documents are listed in the continuation of Box C.
 ☐ See patent family annex.

* Special categories of cited documents	*T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	*X* document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"B" earlier document published on or after the international filing date	*Y* document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"I" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	*Z* document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 27 FEBRUARY 1998	Date of mailing of the international search report 09 APR 1998
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer DAVID SAUNDERS Telephone No. (703) 308-0196

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US97/21857

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

Please See Extra Sheet.

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☒ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US97/21857

A. CLASSIFICATION OF SUBJECT MATTER:

IPC (6):

A61K 38/04, 38/17, 39/00, 48/00, 49/00, 51/08; C07H 21/00; C07K 7/00, 14/705; C12N 15/12; C12Q 1/02, 1/68; G01N 33/566

A. CLASSIFICATION OF SUBJECT MATTER:

US CL :

424/1.69, 9.1, 9.2, 9.34, 184.1; 435/6, 7.8, 29, 69.1, 252.33, 320.1; 436/501; 514/2, 12-19, 44, 824; 530/324-330, 350; 536/23.5

B. FIELDS SEARCHED

Electronic data bases consulted (Name of data base and where practicable terms used):

APS: (receptor# or binding(w)protein#)(2a)((modified or oxidized or acetylated or malondialdehyde)(2w)(ldl or low(w)density)(w)lipoprot?)

CAS: (binding(w)protein#)(2a)(ldl or low(w)density(w)lipoprot?)

BOX II. OBSERVATIONS WHERE UNITY OF INVENTION WAS LACKING

This ISA found multiple inventions as follows:

This application contains the following inventions or groups of inventions which are not so linked as to form a single inventive concept under PCT Rule 13.1. In order for all inventions to be searched, the appropriate additional search fees must be paid.

Group I, claim(s) 1-28, drawn to nucleic acids and their use in polypeptide production.

Group II, claim(s) 29-40, drawn to polypeptides and assays therefor.

Group III, claim(s) 41-60, drawn to metabolic study methods of identifying atherosclerosis treating agents and agents identified.

Group IV, claims 61-70, 106-108, drawn to binding assay methods of identifying agents that alter LBP binding and agents identified.

Group V, claims 71-73, drawn to methods of identifying agents binding to LBP nucleic acid regulatory sequences and agents identified.

Group VI, claims 74-89, 96-99, drawn to methods of body treatment and agents therefor.

Group VII, claims 90-95, drawn to methods of in vitro cell treatment.

Group VIII, claims 100, 104-105, drawn to vaccines and methods of vaccination.

Group IX, claims 101-103, drawn to in vivo imaging methods.

Group X, claim 109, drawn to methods of selecting cDNAs.

This application contains claims directed to more than one species of the generic invention. These species are deemed to lack Unity of Invention because they are not so linked as to form a single inventive concept under PCT Rule 13.1. In order for more than one species to be searched, the appropriate additional search fees must be paid. The species are as follows:

LBP-1, LBP-2, LBP-3, homo/heteropolymers of acidic amino acids

The claims are deemed to correspond to the species listed above in the following manner:

Species 1, LBP-1 and fragments thereof: claims 3, 8, 11, 16-17

Species 2, LBP-2 and fragments thereof: claims 4-6, 9, 12-15, 18-21

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US97/21857

Species 3, LBP-3 and fragments thereof: claims 7, 10, 22-23
species 4, homo/heteropolymers of acidic amino acids: claims 81-84

The following claims are generic: 1-2, 24-80, 85-109.

The inventions listed as Groups I-X do not relate to a single inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: The nucleic acid and polypeptides of Groups I and II have distinct structures with no common core structure and they have different functions and are used in different methods.

The methods of Groups III-V for evaluating agents each involve distinct steps and conditions. Further they involve differing reagents, and one method of identification would not suggest the other.

Groups VI-IX, drawn to various methods of body or cell treatment, vaccination or imaging each involve distinct steps and reagents. One would not suggest the other. Further these methods involve distinct steps from the evaluating methods of Groups III-V.

Group X, drawn to a method of isolating a cDNA for an LBP has limitations regarding binding to a modified LDL which are not required to isolate the cDNAs encompassed by Group I.

The species listed above do not relate to a single inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, the species lack the same or corresponding special technical features for the following reasons: LBP-1, LBP-2 and LBP-3 have been disclosed as distinct binding proteins. The sequences of LBP-1, LBP-2, LBP-3, and the homo/heteropolymers differ from one another and could not be predicted any one from any of the others.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US97/21857

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A,P	RAMPRASAD ET AL, "Cell surface expression of mouse macrosialin and human CD68 and their role as macrophage receptors for oxidized low density lipoprotein", Proceedings of The National Academy of Sciences, USA, December 1996, Volume 93, pages 14833-14838. See page 14833, columns 1-2.	1-109
X	SIGMA CHEMICAL COMPANY, Catalogue, 1995. See page 1906, column 1.	60, 67, 70, 96-99

